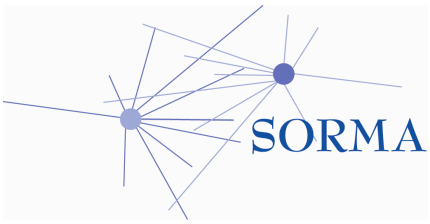

IST-FP6-034286 SORMA

D5.3

Integrated SORMA system & System Manual

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Abstract:

This deliverable describes the final integrated SORMA system, providing both software and user guides. The SORMA prototype is described from a technical point of view that covers the integrated architecture, the behaviour of the main components, and the integration test beds. User guides for the three main categories of end-users (resource providers, resource consumers and SORMA system administrators) are provided that detail installation and configuration steps.

The SORMA prototype software is available on the DVD annexed to this document.

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1. Introduction

This deliverable describes the final integrated SORMA system, providing both software code and user guides. The final integrated SORMA prototype is described from a technical point of view by defining its integrated architecture, by showing how the main components behave, and how the system is currently deployed for testing. User guides for three main categories of end-users: resource providers, resource consumers and SORMA system administrators are included. Each user guide provides install and configuration instructions, and a user-manual. In addition a guide for SORMA system developers is included. The final prototype software is available on the DVD annexed to this document.

1.1. Structure of this Document

This document is structured in the following way:

- **Chapter 1** provides relevant information about this document and its relationship within Work package 5, and provides an overview of the SORMA system's actors.
- **Chapter 2** describes the final SORMA prototype architecture, with a special focus on integration.
- **Chapter 3** provides manuals for the resource providers, specifying: how to install, configure and use the SORMA tools in order to offer resources on the SORMA Grid market.
- **Chapter 4** provides information for resource consumers, specifying: what to install and how to access the SORMA market via GUIs or how to develop a custom client using the SORMA API.
- **Chapter 0** provides information for the SORMA market operators, specifying: how to install the SORMA Grid market and how to configure and maintain it.
- **Chapter 5** provides guides for SORMA system developers.
- **Appendix:** contains code and message examples.

1.1.1. **Annexed DVD**

The annexed DVD contains the SORMA Integrated System.
The DVD content is structured in the following way:

- **/README.txt**: How to use the DVD
- **/docs:** A copy of the user guides.
- **/src/sorma:** A snapshot of the SORMA Subversion source code repository trunk.
- **/src/third-party:** Existing 3rd party source code that was modified under SORMA.
- **/ivy/vendor:** 3rd party libraries (binaries) from the Ivy repositories.
- /**ivy/sorma:** All Sorma-specific binary artifacts (a snapshot of the SORMA Ivy Integration repository).
- **/virtual-machine-images:** Virtual Machine images that can be used to test the SORMA and MOSIX systems (the images come with components already in place, but some configuration is still required to take into account e.g. network settings).

1.2. SORMA Actors

Brokerage of resources over the Grid will benefit Grid consumers, resource owners, outsourcing providers, and new intermediaries. The SORMA platform offers the necessary tools for all the actors, providers, consumers and market operators, involved to join the market, participate in transactions and IT resource realization. SORMA is therefore a complete package making it possible for all types of users to participate.

1.2.1. **Market operator**

SORMA provides the Open Grid Market to perform the brokerage of resources over the Grid, match the users' and brokers' requests and put them into contact with each other.

In a messaging framework user agents and brokers register their requests and capabilities, using the SORMA messaging protocols. Here, software components create resource requirements specifications on behalf of the user, and brokers utilize software components that interpret the information about the available resources, from the resource fabrics, and create the service requested. User agents and brokers utilize an expressive market language, while brokers and resource fabrics adopt a fabric specific language to allow brokers to acquire specific resources. The grid market matches the requests with the advertised capabilities, reports back to the requesting user and generates a Service Level Agreement (SLA) .

Through the data gathering interfaces along all abstraction levels, and the powerful service description tools, the Open Grid Market reveals information about demand and supply accurately. Market or pricing mechanisms are the components that foster information exchange.

SORMA mechanisms ensure a more rigorous allocation of resources and self-organizing resource management. A simple management interface for virtual resources is provided; the surveillance of the running nodes is made through a shared information gathering layer to simplify the brokers' tasks of discovering and keeping track of nodes and their status.

1.2.2. **Resource Provider**

SORMA offers to the ICT resource owners, outsourcing providers, and designated utility providers a complex economically efficient and market-based platform for the supply and trading of their available resources. This includes computational as well as hardware (idle or unused) resources, over the Open Grid Market, for example as services.

Sorma provides the means for resource providers to join and leave the market, by enabling the resource fabrics to register their presence in an Information Gathering Infrastructure. Here, brokers collect the messages (about the available resources and their status) that the resource fabric node sent to the Information Gathering Infrastructure, are able to interpret the information correctly, and communicate back to the user agent; when a broker has received an accept on an offer from the user agent, it communicates to the resource fabric market/reservation service in order to acquire resources in accordance with the generated SLA.

The SORMA platform provides resource owners with economically sound, sustainable and customizable business models by providing methods and tools:

- to express the business model of the resources owners
- for capturing users' reserve prices for resources
- for determining the bidding strategy consisting of various economic pricing models
- to estimate and monitor the quality of the resource management.

1.2.3. **Consumer**

SORMA offers an economically efficient and market-based platform to the consumers of Grid computing power or Grid storage infrastructures for the identification and acquisition of the needed resources. Acquisition and trading support is provided for low-level resources as well as for higher-level services with dependencies, for applications requiring continuous "real-time" allocation of resources, pre-planned batch job allocation, and dynamic (re-)allocation. In addition, client demand can be satisfied not only within an organization but also among multiple administrative domains.

SORMA ensures the means for submitting jobs and monitoring submitted jobs. The user no longer has to be concerned on which resources their jobs are being completed as long as they are performed like specified in the consumer preferences and on time. The user agents act on behalf of the user, being capable to create resource specifications on behalf of the user, communicate with the resource brokers, match the requirements with the capabilities available on the grid market, and get the services needed by the user within a market-based business model.

The SORMA platform provides resource users with intelligent tools to access the Open Grid Market using methods and tools:

- to express the business model of the users
- for capturing users' preferences of each task requiring resources
- for determining the bidding strategy consisting of various economic models
- to estimate and monitor the quality of the resource management.

1.3. Note on Security

The main concept of SORMA security is the ability to have distributed identity management and single-sign-on. This is realized in SORMA by using the SAML protocol for the exchange of security messages and interoperating with other authentication authorities. The vision is that SORMA customers can authenticate in their own organization, obtaining an SAML assertion, and use this assertion in exchange for SORMA credential (i.e. proxy certificate).

1.4. Explanatory Notes about WP5 deliverables: D5.2, D5.3, D.5.4

In order to avoid misunderstandings or ambiguities, it is useful to remember which deliverable is going to deliver the Final software prototypes and related documentation

- **D 5.2: Economic Grid middleware (Prototype/Report**): **"Description and implementation of the prototypical economic Grid middleware"**

D5.2 contains the technical details of the Core Market Services prototype and the EERM and Resource Fabrics which are to be installed at the Provider side.
This deliverable IS NOT going to deliver such components' user guides, which will be delivered into D5.3

- **D5.3: Integrated SORMA system & System Manual (Prototype/Report): "Description of the integrations undertaken, detailed definition of all prototypical system components and manuals are available."**

This (very) deliverable, which includes the description and technical overview of the integrated SORMA system (technical architecture), the role of the components (while their detailed description can be found in D4.x deliverables), and user manuals (technical guides and user guides) about ALL SORMA components (excluding Mosix which will be delivered in D5.4).
This deliverable also includes the software prototype of the whole SORMA market and user agents. Economic Grid middleware prototypes are delivered in D5.2.

- **D 5.4: Market-based Grid OS & System Manual (**Prototype/Report)**: "Description of the implementation and modifications undertaken, detailed definition of prototypical system components and manual are available"**

This deliverable will include software prototypes and user manuals about Mosix OS

2. Technical Description of the SORMA System

This chapter provides an integrated view on the SORMA system: its final technical architecture and its main components (section 2.1), how they behave (section 2.2), how they were integrated and how the whole system was deployed (section 2.3) in order to prepare for testing.

2.1. Integrated SORMA System Architecture

This section describes the final SORMA system architecture from a technical point of view. A high-level view of the SORMA system can be found in the latest deliverable D2.2 – section 2.

2.1.1. SORMA Architecture

The SORMA system is composed of a set of components that provide the required functionality to allow the exchange of resources on an open market across multiple organizations. These components interact following complex communication patterns in a distributed setup.

In this section we present the SORMA's technical architecture, Figure 1 shows a high-level view of the SORMA architecture. How each of those components fulfil the interfaces it exposes will be discussed in the following sections.

The architecture's main components are the Consumer's and Provider's Tools for trading, the Open Grid Market that provides the context upon which the exchange of resources takes place, the Core Market Services, which provide the supporting services for the actual trade to occur and the Security Manager, which provides the cross-system security mechanisms.

On the consumer's side of the market, the Consumer's Intelligent Tools provide the grid applications with the interface SubmitBid to express its preferences, both technical and economical, for resources. To fulfil the application's requirements, the Provider's Intelligent Tools use the aggregated market information, like price ranges, provided by the Core Market Service's Information Publish interface and the Trading interface to submit a bid.

If this bid is successful, the Grid Application receives the credentials to access the resource obtained by the market and uses the SubmitJob interface of the Provider's Intelligent Tools to initiate its utilization. The Provider's Intelligent Tools also provide interfaces to monitor the execution of jobs (monitoring) and to inform of the valid resource allocations.

The Core Market Services component provides interfaces used by the intelligent tools to Search for markets,[1] query for aggregated information about the market and submit bids (Trading). The Security component provides interfaces for authentication and digital signature to Core Market Services, which use them to provide a secure trade environment.

Bids are delivered by the Core Market Services to the Open Grid Market's ProtocolExecutor interface, to be processed by the corresponding market allocation mechanism (e.g. auction protocol). The Open Grid Market also offers interfaces to manage the SLAs, which enforce and define the utilization of the resources, and to make the payments for such resources.

1 It is important to note that this search interface allows the location of markets, i.e. ongoing auctions, but not for the specific items being traded in them.

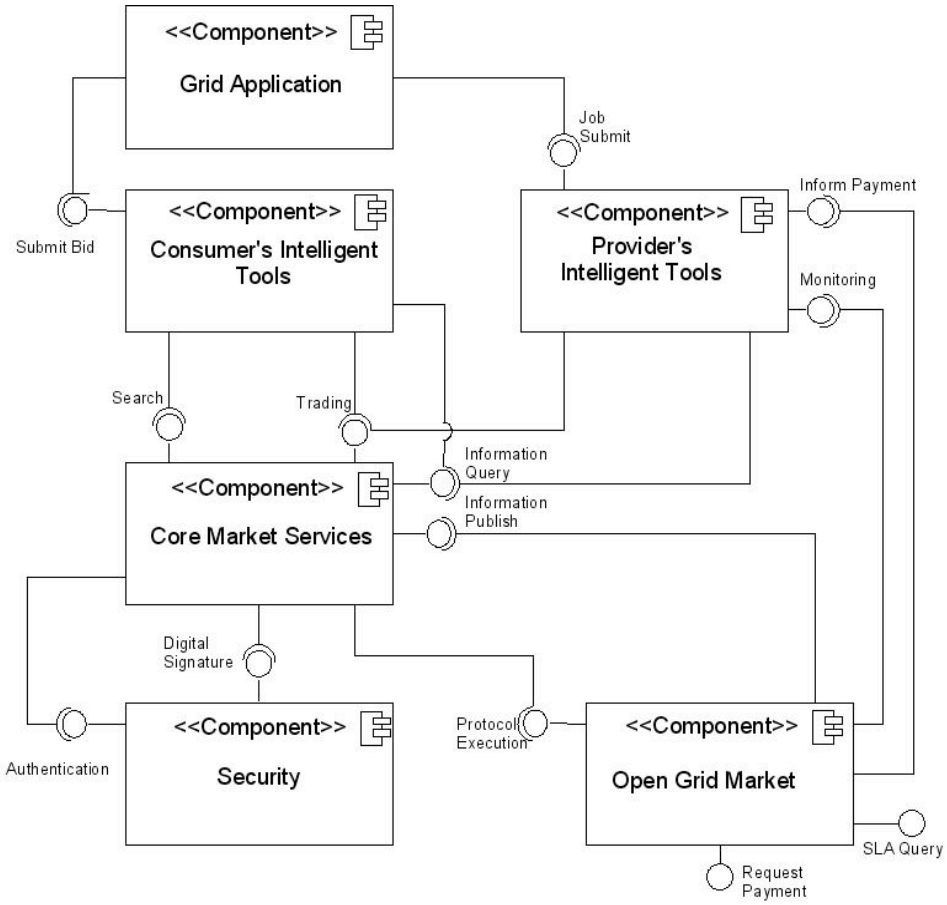


Figure 1: SORMA Technical Architecture

2.1.2. **SORMA Components**

Core Market Services:
Figure 2 details the internal components of the Core Market Services. It is formed by four services: the Market Information, Market Exchange, Market Directory and Logging.

The Market Information Service provides the interfaces InformationQuery and InformationPublish to manage the aggregated information of the market, such as maximum and minimum prices in a certain market.

The Market Exchange provides the Trading interface to allow participants to engage in negotiations, exchanging proposals (bids) and eventually reaching an agreement. Bids received from consumers and providers are forwarded to the Open Grid Market's ProtocolExecutor interface to be processed by the market's allocation protocol. It also requires the Authentication and DigitalSignature interfaces provided by the Security Management component to protect the interaction among participants.

The Market Directory offers the Search interface to look for existing markets, which are registered using the Registry interface by the Market Exchange. To be available to trading agents, markets must register themselves using the Trade interface.

The Logging service offers a secure, persistent record of the transactions for auditing and dispute resolution. It is also used to recover the state of negotiations in case of a failure of the Market Exchange service.

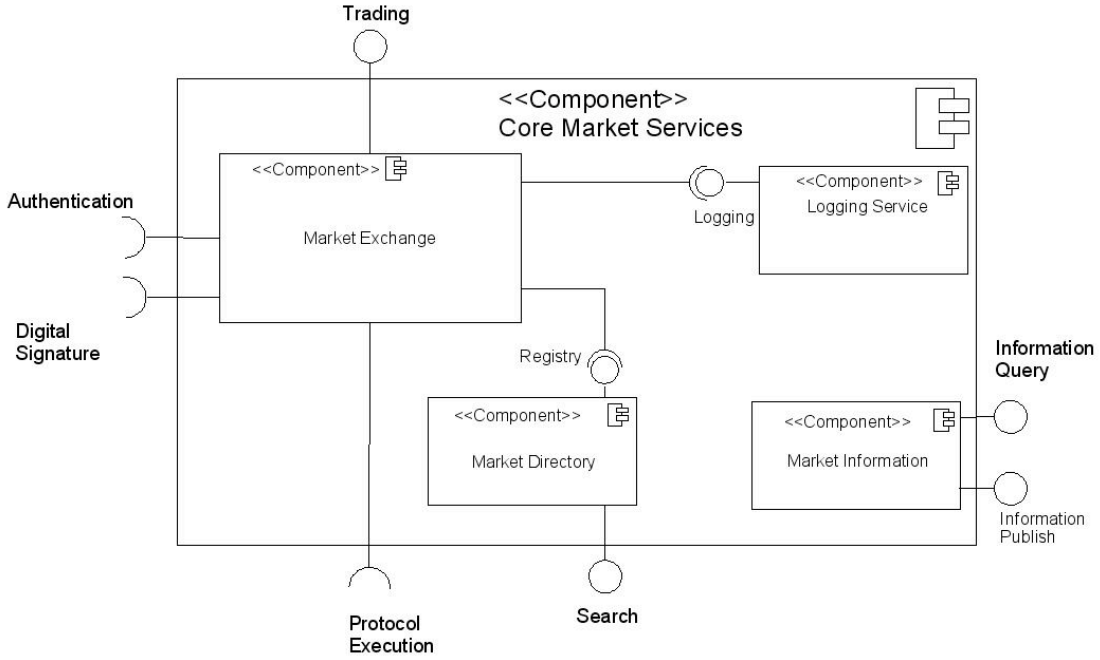


Figure 2: Core Market Services

Open Grid Market:

Figure 3 details the internal components of the Open Grid Market and their interactions. The Trading Manager provides the protocol execution interface and is used to process the bids received from participants and apply the market's allocation protocol. A Match Making component allows the Trading Manager to match bids using technical and economical criteria. Matches are submitted to the Market Exchange using the Trading interface, while the corresponding Agreements are notified to the SLA Manager's AgreementNotification interface. The Trading Manager also provides Market Information with anonymized information about the resource allocation using the InformationPublish interface.

The SLA Manager oversees the fulfilment of resource allocation agreements. It uses the Provider's Tools Monitor interface to track the status of the job execution and resource provision. It also receives the payment instruction from the application users. Based on the agreement conditions and the actual resource utilization information, it calculates the required payment and uses the Payment component's ExecutePayment interface to realize it. Once the payment has occurred, it informs the Provider's Tools of the payment to authorize the utilization of the resource and also to uses the Core Market Service's PublishInformation interface to publish the final price.

The Payment component is a gateway for actual payment mechanisms, for example credit cards, online payment systems and virtual currencies. Its main function is to control the execution of the payment transactions.

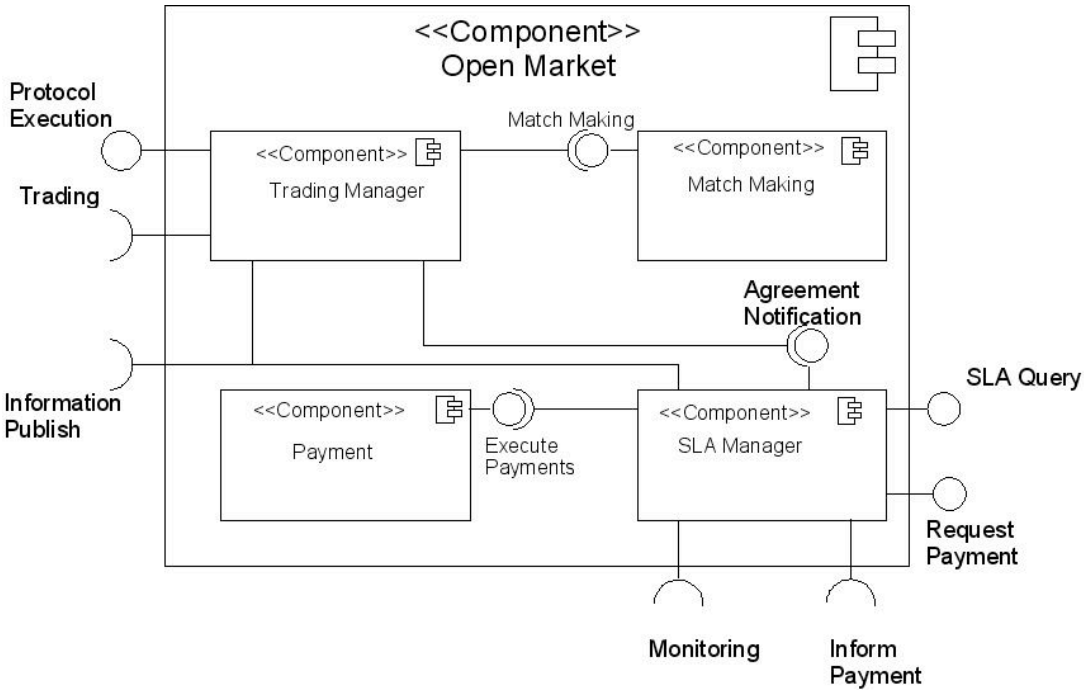


Figure 3 Open Grid Market

Provider's Tools:

Figure 4 shows the internal component of the Provider's Tool. The EERM provides the interfaces to submit jobs and monitor their execution. It also issues requests to the Bid Generator component to offer a resource in the market as they become available, using the BidSubmission interface. The EERM must also be informed by the Open Grid Market about the authorization to use the resources using the InformPayment interface.

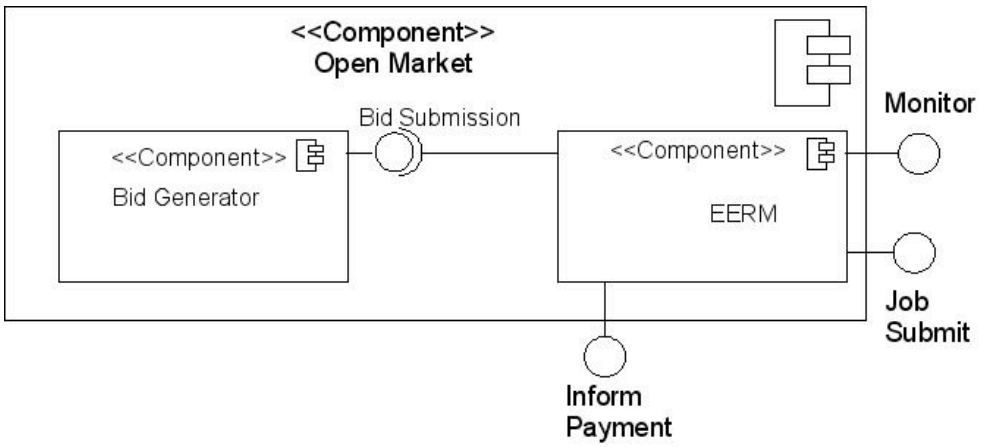


Figure 4: Provider's Tools

2.2. SORMA Components Behaviour

This section shows how the components previously described interact in the SORMA workflow.

2.2.1. Resource registration

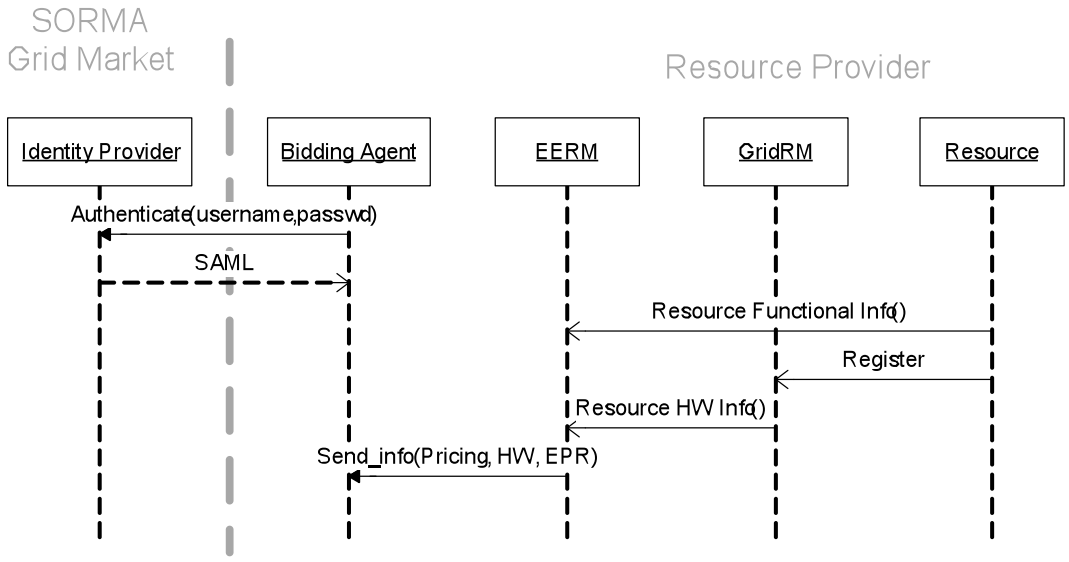


Figure 5: resource provider registration sequence diagram

Figure 5 shows the workflow for the resource registration, where the bold-grey discontinuous line represents domain separation. The figure shows how the EERM is authenticated in the Identity Provider to be allowed to send secure messages to SORMA Grid Market domain.

When a new hardware Resource is attached, it notifies the EERM of its existence and sends some functional information, for example its host name and if the resource hosts a Web Service or a GridSAM middleware for batch executions. The resource must also be registered on GridRM gateway, and then GridRM will notify the EERM with the availability of a new Resource. The EERM is now able to query the Hardware description and Monitoring Data. With the data provided by the resource and the GridRM gateway, the EERM is now able to create an EJSDL document with the resource description and some economic auxiliary data. The EJSDL document is sent to the provider's Bidding Agent, and the Resource Provider is now ready to start a negotiation for the sale of the resource or service.

2.2.2. **Batch resource/service sale**

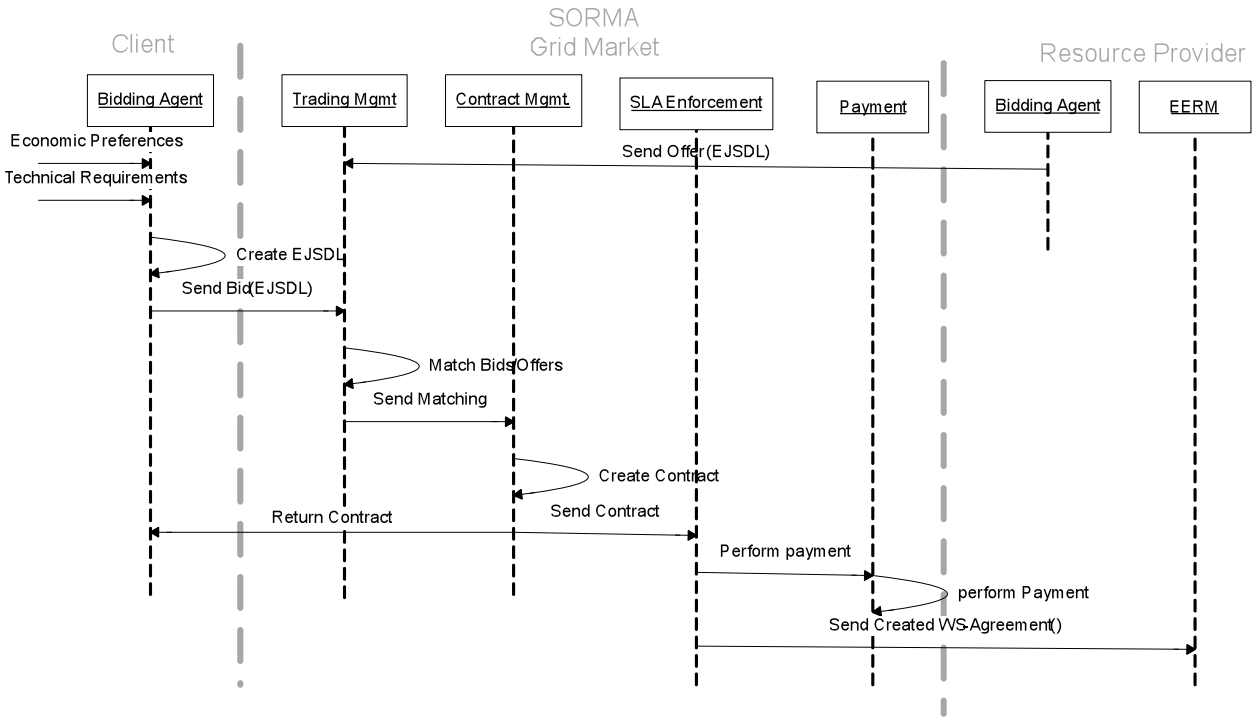


Figure 6: Resource Sale sequence diagram

Figure 6 can be seen as the continuation of Figure 5 and shows the process that occurs upon the submission of an EJSDL document to the Provider's Bidding Agent. Once the Provider's Bidding Agent gets the resource information with some economic data, it creates the offer and sends it to the market, concretely to the Trading Management component. In an external and independent process the Client's Bidding Agent creates a bid from the Economical and Technical Preferences of the end user, and also sends it to Trading Management.

Trading Management will search for matches between all the bids and offers and, when a match occurs, it notifies the Contract Management component, which will create an SLA, and later send the generated SLA to SLA Enforcement, which will monitor the constitutional terms on the SLA to ensure that all terms are adhered to. Trading Management then sends the contract to the consumer and provider (the SLA participants), to notify them of the match and consequent SLA. In this graph, we assume that Client's Bidding Agent has previously been authenticated by the Identity Provider, and that all the inter-domain messages incorporate SAML assertions for authenticated communications.

2.2.3. **Resource Usage**

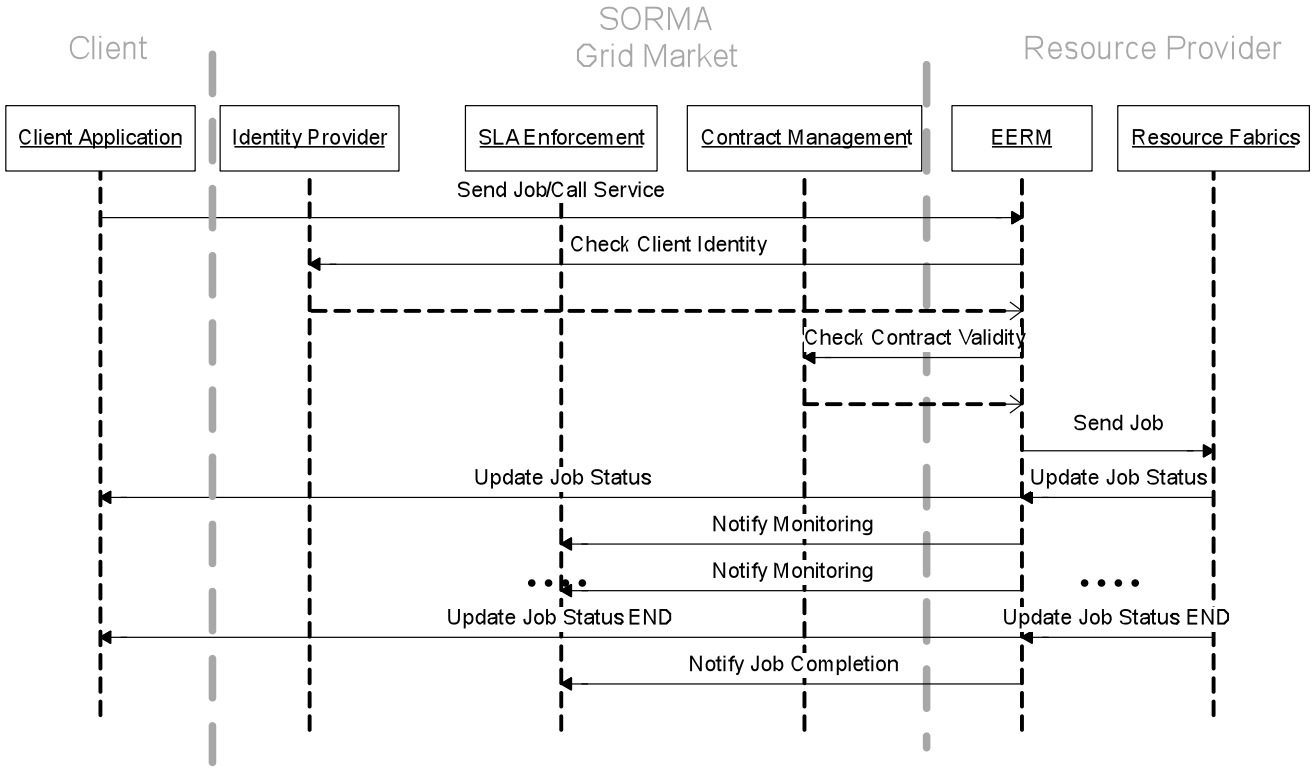


Figure 7: job submission sequence diagram

Figure 7, which again can be seen as a continuation of Figure 6, shows the interaction between the SORMA components when a job is being executed. When the EERM receives an EJSDL from the Client Application, the EERM must check the correct identity of the Client Application and that it has attached a valid ContractId. The EERM may need to contact Contract Management to assure the validity of a contract. After sending the job from EERM to the Resource, the resource notifies continuously about the changes in the status of the execution, and EERM forwards them to the Client Application. In addition, the EERM, periodically, response to requests for monitoring data from SLA Enforcement, to enable the monitoring of SLA adherence by the provider. Specifically, if the terms in the SLA are being fulfilled correctly and, in case they are not, take reactive measures such as renegotiation or ask the EERM for a redistribution of the assigned resources. Finally, when the Resource notifies to the EERM that the task has been finished, the EERM forwards this notification to the Client Application and the SLA Enforcement. The SORMA cycle is finished here.

2.2.4. **Special case: Future Markets**

Since the EERM allows the advanced reservation of resources, future markets can be implemented in SORMA. The main change to support reservations must be implemented in Trading Management component (see Figure 8). In the technical/economical matchmaking process, when a pair of bids/offers matches, Trading Management component must ask to the Provider's Bidding Agent if a concrete amount of resources could be allocated in a specified time slot. The Bidding Agent will forward this question to the EERM, which will respond as appropriate, in case of "no", will provide an alternative allocation for this concrete petition.

Following this process, Trading Management will confirm/deny the reservation. If both parties arrive at an agreement, the match is returned and the normal workflow of SORMA continues. If not, the

Trading Management component will try to perform a reservation with the next pair of matched bid/offers.

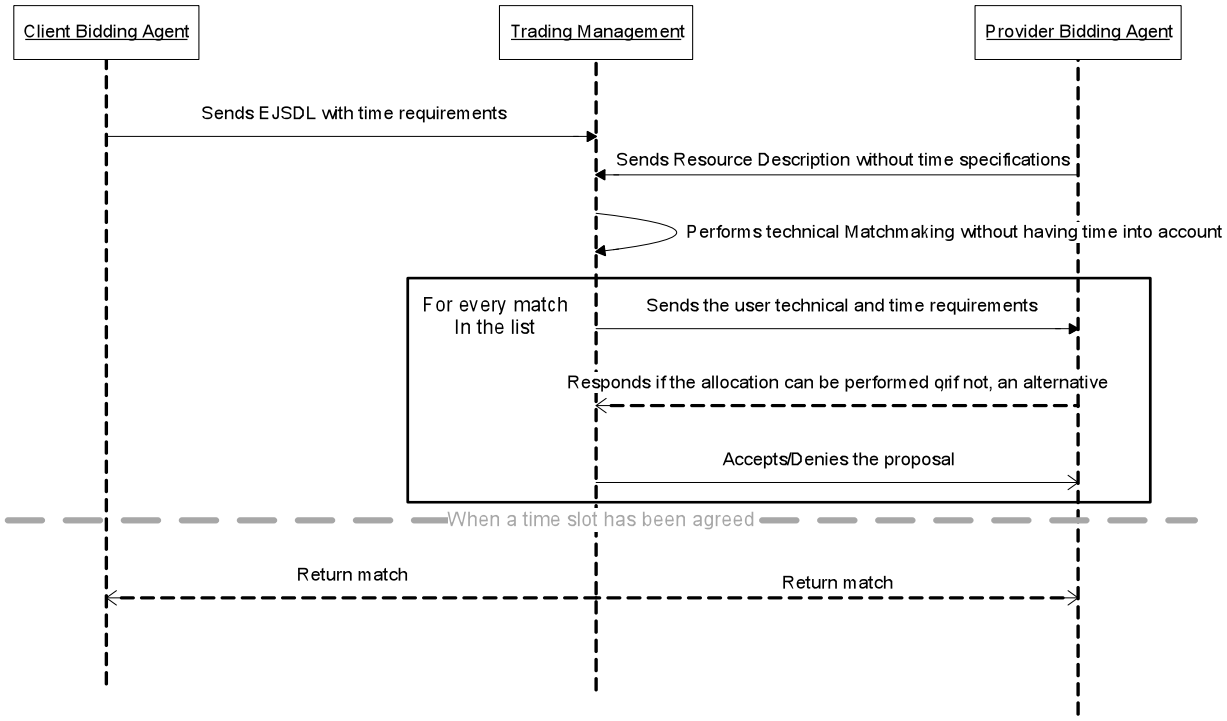


Figure 8: interactions for reservation of resources

2.3. SORMA Deployed System

Figure 9 shows how the components described in the previous sections are deployed from a logical point of view. The figure shows the three main stakeholders (Consumers, Resource Providers and the SORMA Grid Market), and the components that are required for each of them:

- **Consumers** will be running the client-side Intelligent Tools, and/or having their own client application accessing the SORMA Market through the SORMA API (see next section 4.4.1)
- **Resource Providers** will be running the provider-side Intelligent Tools and the EERM, in order to offer their resources to the SORMA market and to Consumers
- **SORMA Market** will be running all the other components, namely the Core Market Components and the Security Services

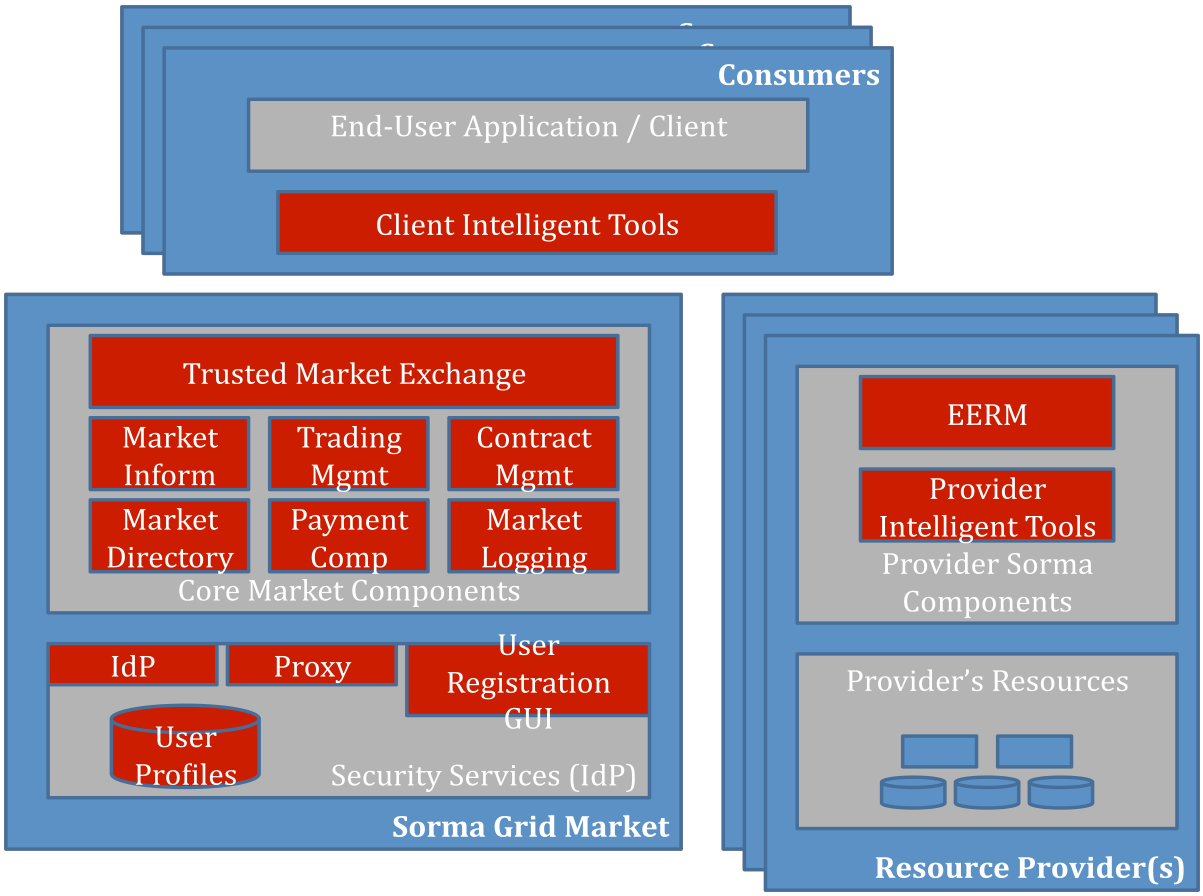


Figure 9: high-level components deployment view

2.3.1. SORMA Test beds

In order to test **integration**, components have been deployed onto two main test beds: 1) the ***development test bed***, and 2) the ***wide-area distributed test bed***.

A) Development test bed

For the deployment and testing of components, a test bed consisting of virtual machines was set up in the second year of SORMA at the UPC.

The test bed consists of two PCs (PC1 and PC2), each with a quad-core processor, 4 GB of RAM, and 250 GB of disk. For the virtualization Xen is used. The operating system is Linux Fedora 8. For the management of the virtual machines in each PC, a tool developed at UPC called the *Local Resource Manager* (LRM) is used.

This type of test bed for the purpose of providing quickly a flexible test bed for SORMA has the following advantages:

- With virtual machines, the users can be granted – if needed - root access (Linux) or administrator access (Windows) to their virtual machine. The root or administrator permissions are sometimes needed to install software and deploy certain components, which is not possible with the more

restricted user access. Traditional approaches not based on virtualization must often apply non-trivial solutions to overcome these limitations.

- The isolation of virtual machines between each other is an important feature, since then the activities of some users do not influence on the resources available to other users. In order to achieve this isolation, the virtualization tools allow making strict resource assignments to each virtual machine. While with the traditional approach without virtualization, where many users work within their account simultaneously on the same operating system and the same physical PC, a computer intensive activity of a certain user does usually affect the resources available to the other users

- Virtualization makes it possible to boot different operating systems in the virtual machines. A share of the physical resources of the PC is assigned to each virtual machine. The practical usage is that some of the PC's virtual machines may be configured to have Linux as the operating system, while others may have Windows.

The Local Resource Manager is a software infrastructure developed at UPC, which allows the management of virtual machines in desktop PCs. The implementation of the LRM interacts with Xen for the virtualization of the PC. The Local Resource Manager tool provides a menu-guided access to the functionalities of Xen, which allows the administrator to perform configuration, setup and maintenance of the virtual machines.

Once all virtual machines are set up, their status can be checked. This is shown in the following figures where information concerning the different virtual machines set up for the SORMA developers can be seen. In Figure 10 the information obtained from the LRM is shown for PC1. Figure 11 shows the virtual machines in PC2. It can be seen that information about the operating system, status, and assigned MHz of the virtual machines is given. The column QoS type further indicates one of the 4 operating policies, which can be assigned to the virtual machines. All of the 4 policies assure to the virtual machines the MHz assigned if this CPU usage is needed by the VMs. The QoS levels are then different in terms of additional CPU, however, which is then assigned to the VMs from the unused/idle CPU resource.

```
LRM Client Beta 0.2 : user1 connected to 147.83.30.2
Action ("h" for help):

VM(ID)  OS  share  Status  Price QoS(MHz)  QoS(type)
==================================================
pc2   linux 0.05  running  0.12   500          fixed
pc3   linux 0.04  running  0.10   400          fixed
pc4   linux 0.04  running  0.10   400          fixed
pc5   linux 0.04  running  0.10   400          fixed
pc6   linux 0.04  running  0.10   400          fixed
pc7 windows 0.04  running  0.10   400          fixed
pc8 windows 0.04  running  0.10   400          fixed
pc9 windows 0.04  running  0.10   400          fixed
```

Figure 10: Deployed VMs in PC1

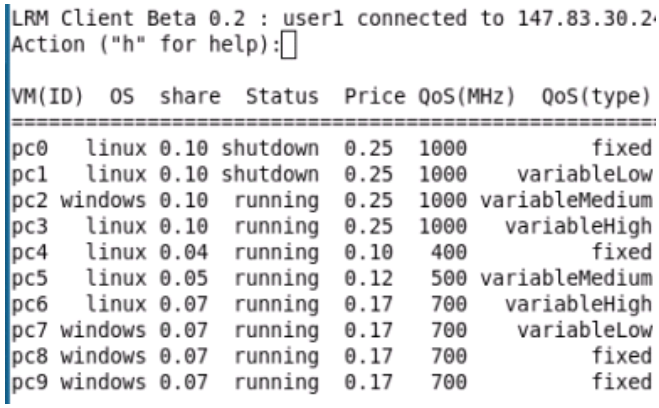


Figure 11: Deployed VMs in PC2

Deployed SORMA components:

SORMA developers have basic access with *ssh* to the virtual machines, both Linux and Windows. Alternatively, the access with a graphical interface to the Windows virtual machines is possible using the Remote Desktop tool, which is available both in Windows and Linux. The graphical access to Linux virtual machine can be achieved with tools similar to VNC.

The virtual machines are assigned to the developers of SORMA, where each developer works on one or more virtual machine. The components of the software project are networked. Some apply the client-server model, others use a Peer-to-Peer infrastructure for communication. Table 3 and Table 4 indicate the components deployed on PC1 and PC2, respectively.

The typical usage of the virtual machines in our use case is for the deployment of the already developed components, such that the interaction between them can be tested on the test bed. The development of the software components itself is done locally at the machines of each SORMA partner. Test runs are therefore the main activity in the test bed.

VM	Component type	OS
pc0	Admin	Linux
pc1	Admin	Linux
pc2	Trading Management	Linux
pc3	Security Service	Linux
pc4	Market Exchange	Linux
pc5	Bid Generator	Linux
pc6	Bid Generator	Linux
pc7	Trading Management	Windows
pc8	Testing tools	Windows
pc9	Bid Generator	Windows

Table 2: SORMA components installed on the virtual machines of PC1

VM	Component type	OS
pc0	Admin	Linux
pc1	Admin	Linux
pc2	TXT application	Linux
pc3	MIS	Linux
pc4	Correlation Sys application	Linux
pc5	EERM	Linux
pc6	EERM	Linux
pc7	Bid Generator	Windows
pc8	Correlation Sys application	Windows
pc9	TXT application	Windows

Table 3: SORMA components installed on the virtual machines of PC2.

Monitoring of the virtual machine resource usage:
The LRM tool offers activity recording of each virtual machine with different time granularity (hours, days, weeks) and about different type of actions (CPU, bandwidth in terms of incoming and outgoing traffic, and read and write disk access).

In order to assess the resource usage of the virtual machines, we have recorded the activity on each of the virtual machines in each of the three time granularities. For illustration, the next figure shows the CPU resources used by each virtual machine of PC2 during a one hour timeframe is shown. It can be seen that the CPU usage of the virtual machines has been quite low in this hour and that the virtual machines could easily cope with the activities made by the deployed components.

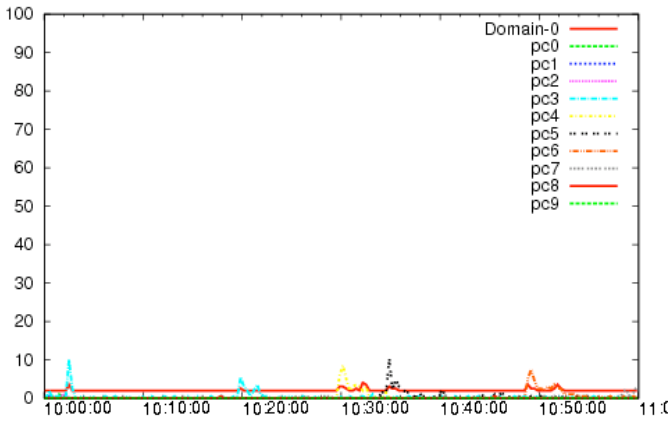


Figure 12: CPU Activity of the virtual machines during one hour

The next figure shows the traffic per virtual machine in PC2 during a one hour timeframe. Some of the peaks - which are not high compared to the available bandwidth – could be due to the downloading of software. The communication within the deployed distributed application is characterized up to now by the exchange of short and not too frequent messages between the components. Up to now, no performance problem with bandwidth was identified. Given the PC's network connection bandwidth, larger traffic could take place and should not produce bandwidth problems. Extreme scenarios like heavy concurrent communication activities in all the ten virtual machines, which could potentially bring communication problems, have not yet been part of the usage pattern of the deployed components in the virtual machines.

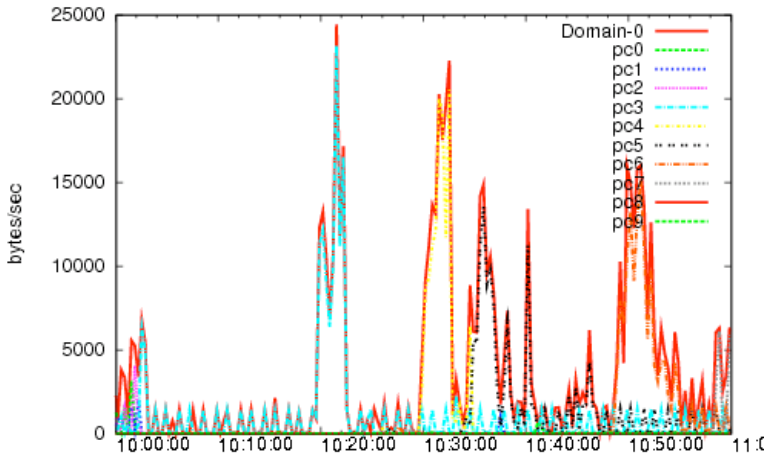


Figure 13: Traffic in the virtual machines during one hour

Test bed evaluation:
Taking into account that the test bed has been operational for several months now, we found that building the development test bed with the virtual machine approach was an appropriate solution for the project's purpose. It could be set up very quickly, is extensible, and allows flexibly to changing demands regarding the virtual machine characteristics. The virtual machines of the test bed allow all components to be networked and make them accessible from the Internet.

B) Wide-area distributed test bed
A distributed test bed has been set up with machines contributed by Consortium partners in order to support testing over the wide-area. The distributed test bed has been constructed in an incremental manner with sites such as BFM and UKA starting out as separate test beds for exercising the entire SORMA system in parallel. The sites are now used for scalability testing on the wide-area test bed, but also revert back to independent test beds as necessary, to investigate issues with different SORMA configurations.

For example, currently most of the components are deployed at UKA and are running on different physical machines, in contrast to the use of virtual machines for the development test bed. The availability of components executing solely on physical machines provides the opportunity to compare component behaviour against that observed in virtual machines, for e.g. identifying race conditions. Furthermore, the components at UKA execute exclusively on separate hardware so that performance testing can take place in a controlled environment without the risk of interference from other SORMA components (on the same machine) contaminating the measurements.

Details of wide-area testing will be reported as part of WP6

2.4. SORMA Software Development Methodology

The software development process in SORMA is executed using a well-defined methodology. The methodology contains the following parts:

- *Development Best Practices*: Survey of literature, links and common rules for software development; Specification of a common methodology and rules for software development.
- *Management of the SORMA Components' source code*: The source code is structured and stored in the SORMA SVN (Subversion[2]); Specification of a common methodology for structuring the source code of the components' stable and trial versions, naming and versioning conventions.
- *Management of the Build, Test and Deployment Processes:* The build, test and deployment processes of the SORMA components are managed and executed using *Apache ANT*[3]-based scripts, which incorporate best practices as well as standardize and simplify the processes of building, testing and deployment. *Apache IVY*[4] is adopted in order to manage and resolve dependencies between the components and 3rd party java-libraries. Furthermore, the components, test-clients and test-files are uploaded, versioned and kept up-to-date in *SORMA IVY*. For the purpose to automate the continuous integration, build and test processes, we adopted *Cruise Control*[5].
- *Continuous Testing of the SORMA Components*: In order to verify the component's functionality and to speed up the integration processes, each component has to implement it's own unit- and integration tests. The unit-tests (JUnit[6]) verify the functionality of the target component. To test an individual component that depends on interaction with other components, the other components are implemented as a Mock Objects[7] or Mock Service Objects.
- *Debugging and Issue Tracking*: In order to report, resolve and document the solutions of issues arose during the software development processes, we selected to adopt *Bugzilla*[8].

2.4.1. Revision Control

The SORMA Subversion revision control repository is structured into the following top-level directories:

- **`.meta`**: Tools and scripts for project administrators, developers do not need to access these
- **`build-bootstrap`**: Developers must export this directory to be able to use the standard SORMA build mechanisms
- **`code`**: The root of the SORMA source code
- **`notes`**: This is documentation that is interesting for the project, but not required by users as part of a source code download.

The code directory has 3 subdirectories:

- **`branches`**: Contains component code or component-level code branches (e.g. for release branches, developer trials, branches for non-trivial bug fixes
- **`tags`**: For tagging a particular release of SORMA

[2] https://portals.rdg.ac.uk/sorma/svn/src/
[3] http://ant.apache.org/
[4] http://ant.apache.org/ivy/
[5] http://cruisecontrol.sourceforge.net/
[6] http://www.junit.org/
[7] http://www.junit.org/taxonomy/term/8
[8] http://www.bugzilla.org/

- **`trunk`**: The latest development version of the SORMA source code and support files are located under this directory.

NOTE: The `trunk` and `build-bootstrap` directories are located on the accompanying DVD (under the `src` directory). The SORMA SVN is available at: `https://portals.rdg.ac.uk/sorma/svn/src/.`

The structure of the code/trunk SVN folder conforms to the layers of the SORMA architecture:

- **`common:`** a library that provides functionality required by all components across the whole of SORMA. For example base logging classes and custom unit testing assertions.
- **`coreMarketServices:`** contains subdirectories for the following components: marketExchange, marketInformation, logging and marketDirectory
- **`exampleIvyComponent:`** an example component that is used to help introduce developers to the build and component publishing mechanisms.
- **`intelligentTools:`** contains subdirectories for components that comprise the intelligent tools, including: agent services, the bid generator, demand and supply modeling, and associated portlets that are required at the consumer and provider sides of the market.
- **`openGridMarket:`** contains subdirectories for components required for the SORMA market, including: Trading Management, The Economically Enhanced Resource Manager (EERM), Matchmaking, Payment services, Security and Contract Management.
- **`pilotApplications:`** contains code and test data for the Correlation Systems pilot application.
- **`resourceFabrics:`** contains subdirectories for components related to the management of resource fabrics.
- **`shared:`** contains subdirectories for libraries and services that are shared across multiple SORMA components, for example SORMA message protocols, shared log4j configuration files, and the logging service used to demonstrate internal SORMA state for demonstration and debugging purposes.

Each SORMA-specific component's source code is packaged under the `eu.sormaproject` name space.

2.4.2. Build mechanisms using Apache ANT and IVY

Apache Ant and *Apache Ivy* are build and dependency tools, respectively, that are used to support a common and consistent methodology for the SORMA development process.

Apache Ant is a Java-based build tool allowing development of software across multiple platforms[9]. Ant provides flexible configuration mechanisms for the build-process by specifying so-called targets that are implemented using an XML syntax. Targets are defined for tasks such as e.g. build directory preparation, code compilation and packaging. Adopting best practices for *Apache Ant*-based development, SORMA offers various 'standard' templates (build files) for building libraries, applications, Web Services and JSR-168 portlets. The standard build templates (located in the `src/build-bootstrap` directory on the DVD) are imported into component-specific build files, resulting, in the simplest case, in developers only having to create a simplistic 7 line long build file in order to build, package and publish their component to the SORMA-wide integration testing repository. The standard build templates reduce redundancy across the project and do not require developers to become experts in using Apache Ant.

[9] http://ant.apache.org/manual/index.html

Apache Ivy[10] is a tool that enables the automated management – recording, tracking, resolving and reporting – of software dependencies. *Apache Ivy* is powerful tool which is tightly integrated with ant and enables a flexible configuration of dependencies. It provides various Ant-tasks ranging from dependency resolution to dependency reporting and artifact publication. An important feature is that Ivy resolves transitive dependencies between components and libraries.

In SORMA we have configured a number of Ivy repositories that contain both SORMA developed components as well as 3rd party dependencies that are required to build and execute SORMA components. Repositories include:

1. **Release:** Contains official SORMA releases that are made available via the SORMA Website. Releases are generated automatically in response to a request from the developer leading the release effort. The release is built and packaged directly from Subversion and takes transitive dependencies from the Vendor repository. The Release repository is read-only via HTTP; Developers are not able to write artifacts to this Ivy repository directly.
2. **Integration:** A repository shared over the network that all developers use to publish/retrieve components as part of the integration testing efforts. A copy of the integration repository contents can be found on the DVD accompanying this report under the `/ivy/sorma` directory.
3. **Vendor:** SORMA currently has 3 separate vendor repositories that contain 3rd party libraries. These include:
    a. **Sorma-vendor:** All developers have read-write access so that they can publish new libraries (jars) as required by their components. A snapshot can be found on the DVD under `/ivy/vendor/sorma-vendor`.
    b. **Maven-mirror:** A partial mirror of the public Maven repository with name space and other meta data issues associated with the public Maven repository resolved. Frequent down-time and incorrect metadata entries at the public Maven repository prompted consortium to import and host our own partial mirror. A snapshot can be found on the DVD under `/ivy/vendor/maven-mirror`.
    c. **Riotfamily-mirror:** A mirror of the Riot Family project's Ivy repository. A snapshot can be found on the DVD under `/ivy/vendor/riotfamily-mirror`.
4. **Local:** A private repository located on each developers' machine. Used to publish artifacts for testing locally as part of single developer integration and unit testing.
5. **Cache:** Not strictly a repository, the cache is located on each developer's machine and holds copies of artifacts that have previously been downloaded from each of the repositories listed above. The cache removes the need to repeatedly download artifacts (that have not changed) from the remote repositories. Apart from saving bandwidth, the cache allows developers to continue working when they are offline (e.g. using a laptop at an airport or on a train).

Further details of the build mechanisms can be found in Section 5 SORMA System developer guide.

[10] http://ant.apache.org/ivy/history/latest-release/index.html

3. Resource Providers Manuals

3.1. Introduction

A Provider who wishes to offer their resources on the SORMA market needs to install and run the following components:

- Provider Side Intelligent Tools
- Economically Enhanced Resource Manager (EERM)

All components can be found on the SORMA system DVD, as described in section 1.1.1 of this document

3.1.1. **Pre-requirements**

The Economically Enhanced Resource Manager and supporting components have been tested on the following platform:

- Linux kernel 2.6 or later.
- Sun Java Development Kit 1.6

A number of network ports need to be open through the provider's organisational firewall in order that the provider-side components can communicate with the core SORMA services that are running on the SORMA test bed. In addition a number of ports are required to be open between the machine(s) hosting the SORMA provider services. During individual components' installation instructions, ports will be specified whenever necessary.

3.2. Installation and Configuration Guide

3.2.1. **Provider-side intelligent tools**

The provider-side **Intelligent Tools** consist of **Business Modelling**, **Supply** and the **Offer Generator** components.

The **Business Modelling** component provides a message format for describing economic and technical preferences. The technical and economic preferences are specified in **EJSDLPrivate** templates (see section 4.4), which are stored locally and can be individual for each resource type. Each time a resource is free, the local provider EERM invokes the **Offer Generator** Web services through submitting of an EJSDLPrivate document.

The **Supply Modelling** component offers a Web-based GUI (Portlet) to enable simplified description of technical requirements for jobs, imported and exported in JSDL data format. The same GUI is used for a technical description of a provider resource offer.

Installation instructions consist of:

a. **Install, configure and test the installation of the Offer Generator**
b. **Use pre-defined EJSDLPrivate templates in case of an application based invocation**
c. **Install and configure the Supply Modelling Portlet in case of a web based invocation**

a. Install, configure and test the installation of the Offer Generator

a.1) Prerequisites

- Tomcat 5.5 with installed JAX-WS: copy JAX-WS jars into Tomcat's directory /common/lib
- Jakarta's commons-io.jar and commons-fileupload.jar: copy both jars into Tomcat's /common/lib

a.2) Download from the SORMA DVD the AgentService.war:

`/ivy/sorma/eu.sormaproject/AgentService/LATEST/AgentService.war`

a.3) Deploy the AgentService on an installed and pre-configured tomcat server

As described in *Prerequisites* using the Tomcat "WAR file deploy manager" - check if the AgentService is available on:

```
http://<HOSTNAME>:<PORT>/AgentService/AgentService
```

This should return information similar to that shown below:

Web Services

Endpoint		Information	
Service Name:	{http://server.web.sormaproject.eu/}AgentServiceService	Address:	http://147.83.30.215:16789/AgentService/AgentService
Port Name:	{http://server.web.sormaproject.eu/}AgentServicePort	WSDL:	http://147.83.30.215:16789/AgentService/AgentService?wsdl
		Implementation class:	eu.sormaproject.web.server.AgentService

a.4) Setup the agent.properties file in the Tomcat directory:

```
$CATALINA_HOME/webapps/AgentService/WEB-INF
```

- **AgentService**: Set the *IP* and *port* of the AgentService
- **Core Market Services**: Set the *IP* and *port* of the Core Market Services
- **Market Information Service** Set the *IP* and *port* of the Market Information Service
- **Trading Management** Set the target *auction name*, running on *Trading Management*. This should be later automated, by requesting a description of the registered auctions from the *Core Market Services*.

a.5) Configuration

Edit the following values to suit your setup:

```
#################################
#BidGenerator specific properties
#################################

# Public address of the AgentService Request Executor
bidgenerator.public.host localhost
bidgenerator.public.port 8080
bidgenerator.policy.dir  policy

# Public address to the Market Information Service
bidgenerator.mis.host pcmargenat.ac.upc.edu
bidgenerator.mis.port 8880

# Static properties for Trading Management
bidgenerator.auctionName theAuction

# Address to which the Core Market Services (Market Exchange) respond to the
BidGenerator
bidgenerator.exchange.service.host localhost
bidgenerator.exchange.service.port 8090

# Core Market Services (Market Exchange) specific properties
client.channel channel.http

## Public address to the Core Market Services (Market Exchange) to which the bid
is submitted
channel.http.param.localAddress localhost
channel.http.param.port 8181
channel.http.param.verbose true

## Define ChannelProvider Properties
channel.http.param.protocol http
channel.http.param.baseUrl
```

a.6) Test the Installation

Download the AgentService client from the SORMA DVD in order to test the AgentService by submitting EJSDLPrivate-based provider and consumer requests.

The AgentService client can be found on the DVD at:
`/ivy/sorma/eu.sormaproject/BidGenerator/LATEST/AgentServiceClient.tar.gz`

To test the correctness of the installation and configuration, unpack and run the test client *AgentServiceTest* with following parameters for each of the consumer and provider requests:

- IP Address of the AgentService
- Port Number of the AgentService
- The example EJSDLPrivate file

To test the AgentService, you should open two command line consoles for each, the consumer request and provider request, and do following call:

```
java -cp agentServiceClient.jar:lib/* eu.sormaproject.web.client.AgentServiceTest
<IP-Address-AgentService-Machine> <PORT-NUMBER> <EJSDLPrivate-FILEPATH>
```

Local tests are executed with the *DUMMY* requests, where the AgentService returns a DUMMY response

```
java -cp agentServiceClient.jar:lib/* eu.sormaproject.web.client.AgentServiceTest
147.83.30.215 16789 ConsumerEJSDLPrivateDataDUMMY.xml
java -cp agentServiceClient.jar:lib/* eu.sormaproject.web.client.AgentServiceTest
147.83.30.215 16789 ProviderEJSDLPrivateDataDUMMY.xml
```

Integration tests are executed with the following requests

```
java -cp agentServiceClient.jar:lib/* eu.sormaproject.web.client.AgentServiceTest
147.83.30.215 16789 ConsumerEJSDLPrivateData-2.5.5.xml
java -cp agentServiceClient.jar:lib/* eu.sormaproject.web.client.AgentServiceTest
147.83.30.215 16789 ProviderEJSDLPrivateData-2.5.5.xml
```

When the request are successful, you will see on both consoles the received "match" document in form of XML-File or receive a status report of the cause, why it was not successful.

b. Use pre-defined EJSDLPrivate templates in case of an application based invocation
Examples of pre-defined EJSDLPrivate templates can be found on the SORMA DVD at e.g. `/src/sorma/trunk/shared/message/test/ProviderEJSDLPrivateData.xml`

c. Install and configure the Supply Modelling Portlet in case of a web based invocation. The source code for the portlets can be found on the DVD at :
`/src/sorma/trunk/intelligentTools/provider/providerPortlets`

c.1) Prerequisites

- Installed Apache Tomcat Application Server Version 5.5 or higher.
- Installed Gridsphere Portlet Container Version 2.2.10.

c.2) Installation
Deploy the Technical Resource Modelling Portlet (TRMP). The portlet war file can be found on the DVD at `/ivy/sorma/eu.sormaproject/technical-resource-modelling-portlet/LATEST/technical-resource-modelling-portlet.war`

Copy the war file to `$CATALINA_HOME/webapps/` and restart the servlet container (Tomcat). Tomcat will extract the Portlet project in webapps in a directory like *technicalResourceModeling*. Enter the following command to enable the *Technical Resource Modelling Portlet* Portlets. If the name of the directory is called *technicalResourceModeling*, the command to be executed is like:

```
touch $CATALAINA_HOME/webapps/gridsphere/WEB-
INF/CustomPortal/portlets/technicalResourceModeling
```

c.3) Administration
On first start up the TRMP creates a java properties file called "resources.prop" in the webapp directory of tomcat. This file contains a variable defining the path where the created JSDL files of the Portlet are stored. If you want your JSDL files to be saved in a specific location you can set the path to the directory here. However the path provided must be relative to the base directory of the TRMP.

3.2.2. **Economically Enhanced Resource Manager (EERM)**

The EERM utilises resource and process monitoring services in order to fulfil its' role. The steps to install and configure the monitoring mechanisms are described in this section. They consist of:

a. Installation of the GridRM Gateway
b. Starting the GridRM
c. Testing the gateway installation
d. Installing and testing the GridRM Portlets (optional task)
e. Installing and running the EERM
f. Installation of the Resource Fabrics
g. Ready

We suggest Administrators first install the GridRM Gateway, then test the gateway using the Simple Test Client. An optional task is the installation of JSR-168 Portlets that provide a Web-based administrative GUI for interacting with GridRM Gateways - Note the Portlets are not required for successful EERM operation.

a. Installation of the GridRM Gateway

a.1) Pre-requisites:

- Bi-directional firewall access for the Tycho port if wide-area communication is required
- The following Network ports are required:

Component	Port number (ServerSocket)	Port description	Container?
GridRM gateway's internal database	54321, but can be any port	Each GridRM gateway has an internal Hypersonic database that it uses. Currently the database is running as a standalone component (good for development and debugging purposes; later we will embed the database into the gateway so that a port is not required). By default the database is located on the same machine as the gateway.	Hypersonic DB
Tycho Mediator	typically 8080, but any can be used	Wide-area communication over HTTPS between Tycho mediators on remote machines, single port. We typically stick to 8080, 80, because most firewalls allow traffic to these ports to pass by default. Port must be open both ways.	Embedded Jetty
GridRM Gateway	dynamically assigned port	Local area socket communications between the GridRM gateway and a Tycho mediator either located within the same JVM or on the LAN.	Embedded Jetty

a.2) Download from the SORMA DVD: **gridrm-tycho-gateway.tar.gz version:**

```
/ivy/vendor/sorma-vendor/org.gridrm/gridrm-tycho-gateway/LATEST/
gridrm-tycho-gateway.tar.gz
```

a.3) Extract gridrm-tycho-gateway.tar.gz, e.g.:

```
gridrm@kat:~/bin$ ls
gridrm-tycho-gateway.tar.gz  gridrm-tycho-gateway.tar.gz.md5

gridrm@kat:~/bin$ tar xzf gridrm-tycho-gateway.tar.gz
gridrm@kat:~/bin$ ls
gridrm-tycho-gateway-0.9.3.1  gridrm-tycho-gateway.tar.gz  gridrm-tycho-
gateway.tar.gz.md5
```

The directory structure of the unpacked file will look like:

```
gridrm@kat:~/bin$ cd gridrm-tycho-gateway-0.9.3.1/

gridrm@kat:~/bin/gridrm-tycho-gateway-0.9.3.1$ ls -F
classes/      dbservermode.sh  gateway.sh  LICENSE.txt       README.txt
sqltool.sh
dbmanager.sh  doc/             lib/        log4j.properties  server.properties
working/
```

a.4) Set the execute bit on the shell scripts:

```
gridrm@kat:~/bin/gridrm-tycho-gateway-0.9.3.1$ chmod 744 *.sh
```

a.5) Edit the `server.properties` configuration file. The file is self-documenting.
Note: Gateways interact over the network with clients via a Tycho mediator. There are two ways to bind a gateway to a mediator:

1. Embedded: The gateway starts its own embedded Tycho mediator as part of the gateway boot sequence (default behaviour).
2. Standalone: The gateway connects to a standalone mediator that is already executing in the gateway's LAN.

The associated settings are explained next.

a.6) Properties that you must assign values to are as follows (if these are not set the gateway will refuse to start):

`tycho.gridrm.gateway.name`

`tycho.mediator.group.name`

`tycho.gridrm.gateway.name`:
This is the Tycho name this gateway is registered with. To ensure uniqueness, it is best to use a scheme similar to the Internet Domain Name System fully qualified hostnames.

Note: The name you choose does NOT already have to be registered in the DNS. If the name below is not unique within the Tycho environment, then Tycho will produce a unique name. However, if you provide a unique name here then your clients will have an easier time of locating a specific gateway, when they perform a search.
`tycho.mediator.group.name`: The tycho mediator group name is the name used by Tycho mediators. All mediators that want to be able to find each other have to be in the same group.

a.7) Optional properties that you may wish to set include:

`tycho.mediator.socket.address=socket://<standalone.mediator.name>:3535/.`
This tells the gateway to connect to the standalone mediator listening at the specified address instead of using the default embedded mediator. If a standalone mediator has been selected, then the `tycho.mediator.group.name` property is ignored.

The gateway uses a hypersonic database for internally storing data and configuration data. Optionally you can update the following database properties, for example if you find that the port required by the database is already in use:

```
server.port
gridrm.gateway.internal.database.user.name
gridrm.gateway.internal.database.user.password
gridrm.gateway.internal.database.url.server
```

b. Starting the GridRM gateway

This section describes how to execute the GridRM Gateway on a Linux platform using the provided shell scripts. If you wish to execute the gateway on a non Linux/UNIX platform, see the section below detailing how to execute using the ant scripts.

b.1) Starting the database

For the moment the GridRM gateway uses a database that is started separately from the gateway (the database is to be embedded within the gateway itself in the future). For now, start the database using the following command:

```
gridrm@kat:~/bin/gridrm-tycho-gateway-0.9.3.1$ nohup ./dbservermode.sh &
[1] 22198
nohup: appending output to `nohup.out'
```

Note: The nohup command means that the database will continue running when you log out of your terminal session.

The standard output will be saved in the file `nohup.out`. You can inspect the file to ensure that the database started OK, e.g.:

```
gridrm@kat:~/bin/gridrm-tycho-gateway-0.9.3.1$ tail -6 nohup.out
[Server@16a9d42]: Startup sequence completed in 543 ms.
[Server@16a9d42]: 2009-01-15 13:26:08.779 HSQLDB server 1.8.0 is online
[Server@16a9d42]: To close normally, connect and execute SHUTDOWN SQL
[Server@16a9d42]: From command line, use [Ctrl]+[C] to abort abruptly
[Server@16a9d42]: [Thread[main,5,main]]: start() exiting
```

You could also use a text editor to view the file. Look for the parts with `Startup sequence completed` and `HSQLDB server 1.8.0 is online`. If the database fails to start, you will see output similar to:

```
gridrm@kat:~/bin/gridrm-tycho-gateway-0.9.3.1$ tail -6 nohup.out
[Server@16a9d42]: Initiating shutdown sequence...
[Server@16a9d42]: [Thread[HSQLDB Server @16a9d42,5,main]]: releaseServerSocket()
entered
[Server@16a9d42]: [Thread[HSQLDB Server @16a9d42,5,main]]: releaseServerSocket()
exited
[Server@16a9d42]: Shutdown sequence completed in 8 ms.
[Server@16a9d42]: 2009-01-15 13:34:50.551 SHUTDOWN : System.exit() is called next
[Server@16a9d42]: [Thread[HSQLDB Server @16a9d42,5,main]]: shutdown() exiting...
```

At this point you need to inspect `nohup.out` a little more closely; there may already be another process listening on the port that you want to use:

```
[Server@16a9d42]: [Thread[HSQLDB Server @16a9d42,5,main]]: Value=in milliseconds.
3000 = 3 seconds, 600000 = 10 minutes
[Server@16a9d42]: [Thread[HSQLDB Server @16a9d42,5,main]]:
server.no_system_exit=false
[Server@16a9d42]: [Thread[HSQLDB Server @16a9d42,5,main]]:
server.restart_on_shutdown=false
[Server@16a9d42]: [Thread[HSQLDB Server @16a9d42,5,main]]: openServerSocket()
entered
[Server@16a9d42]: [Thread[HSQLDB Server @16a9d42,5,main]]:
run()/openServerSocket():
java.net.BindException: Address already in use
        at java.net.PlainSocketImpl.socketBind(Native Method)
        at java.net.PlainSocketImpl.bind(PlainSocketImpl.java:359)
        at java.net.ServerSocket.bind(ServerSocket.java:319)
        at java.net.ServerSocket.<init>(ServerSocket.java:185)
        at java.net.ServerSocket.<init>(ServerSocket.java:97)
        at org.hsqldb.HsqlSocketFactory.createServerSocket(Unknown Source)
        at org.hsqldb.Server.openServerSocket(Unknown Source)
        at org.hsqldb.Server.run(Unknown Source)
        at org.hsqldb.Server.access$000(Unknown Source)
        at org.hsqldb.Server$ServerThread.run(Unknown Source)
[Server@16a9d42]: [Thread[HSQLDB Server @16a9d42,5,main]]: shutdown() entered
[Server@16a9d42]: Initiating shutdown sequence...
[Server@16a9d42]: [Thread[HSQLDB Server @16a9d42,5,main]]: releaseServerSocket()
entered
[Server@16a9d42]: [Thread[HSQLDB Server @16a9d42,5,main]]: releaseServerSocket()
exited
[Server@16a9d42]: Shutdown sequence completed in 8 ms.
[Server@16a9d42]: 2009-01-15 13:34:50.551 SHUTDOWN : System.exit() is called next
[Server@16a9d42]: [Thread[HSQLDB Server @16a9d42,5,main]]: shutdown() exiting...
```

The output confirms that the port is already in use and therefore the database cannot start. You need to either free up the port or find a different port to use (edit `server.properties` appropriately and change to a free port number).
On Linux you can use the following command to determine which process is listening on a port:

```
gridrm@kat:~/bin/gridrm-tycho-gateway-0.9.3.1$ fuser -n tcp 54321
54321/tcp:           22198
gridrm@kat:~/bin/gridrm-tycho-gateway-0.9.3.1$ ps auxw |grep 22198
gridrm   22198  0.0  0.6 1087904 23452 pts/0   Sl   13:26   0:00 java -cp
./lib/hsqldb-1.8.0.7.jar org.hsqldb.Server
gridrm   22275  0.0  0.0   1952   644 pts/0    S+   13:42   0:00 grep 22198
```

First we used the `fuser` command to output the ID of the process bound to port 54321. Then we used the `ps` command with the offending process's ID number (22198) to get details of that process. Looking at the output we see that the process was previously started by us .... wait a minute! This is a database from an earlier experiment with a GridRM Gateway. We shut the gateway down earlier, but forget to stop the database. We don't need the remaining database process, so let's shut it down so that we can reuse the port. We decide to pass the offending process' process ID to the `kill` command:

```
gridrm@kat:/home/users/rdg/gms$ kill 22198

gridrm@kat:/home/users/rdg/gms$ ps auxw |grep 22198
gridrm   22306  0.0  0.0   1956   648 pts/0    S+   13:54   0:00 grep 22198
```

Notice that we did not need to use `kill -KILL` which would have killed the process without letting it first clean up.)

b.2) Starting the GridRM Gateway
Once the gateway's database is running, the gateway can be started:

```
nohup ./gateway &
```

Again standard output is redirected to `nohup.out` and the nohup command means that the gateway will continue running in the background when you log out of your terminal session. Make sure that the gateway started successfully by inspecting `nohup.out`, e.g.:

`cat nohup.out` for a static snapshot of the file, or `tail -f nohup.out` to see changes to the file in real-time.

`nohup.out` will contain a number of messages ending with:

```
INFO: Driver registration successful:
uk.ac.port.dsg.gridRM.info.providers.gangliaGridRMv2.GangliaGridRMv2Driver
07-Sep-2007 21:47:07 uk.ac.port.dsg.gridRM.info.localLayerCore.GridRMDriverManager
registerDefaultDrivers
INFO: **************DRIVER REGISTRATION PHASE COMPLETE ************************
```

At this point the gateway is ready for action; it has registered with the Tycho registry, tested access to the internal database, successfully loaded the default resource drivers and is waiting to receive client requests

c. Test the gateway installation

The Simple Test Client can be used to test that the GridRM gateway is accessible over the network and to retrieve sample data.

c.1) Download and unpack the gridrm-simple-test-client from the DVD:

```
 /ivy/vendor/sorma-vendor/org.gridrm/gridrm-simple-test-client/
LATEST/gridrm-simple-test-client.tar.gz
```

c.2) Edit the config.properties file to point to your gateway (the file is extensively commented)

c.2) Install and run the test client against your gateway, e.g :

```
yabalka2:gridrm-simple-test-client-0.9.2 gms$ ./simpleTestClient.sh
```

If you see the following at the end of the Simple Test client's standard output or log file, then you have successfully managed to contact the gateway and perform a simple query. Depending on whether you have just installed the gateway or have been using the gateway for some time, you will have 0 or more resources reported. In this example we have 0 because we have just installed the gateway and have not registered any resources yet.

```
INFO [main] [SimpleTestClient] - Start off by listing the resources that are already registered at the gatway:

 INFO [main] [SimpleTestClient] - Requesting the list of resources registered with gateway...

 INFO [main] [MonitoringImpl] - Resolving address for gateway: gridrm-gateway.obufki2.lan...

 DEBUG [main] [SimpleTestClient] - After requesting the list of registered resources

 DEBUG [main] [SimpleTestClient] - Resource length is: 0

 INFO [main] [SimpleTestClient] - The gateway does not have any resources registered.

 INFO [main] [SimpleTestClient] -
```

If you experience problems connecting to the gateway, please refer to the GridRM troubleshooting guide at: https://portals.rdg.ac.uk/gridrm/index.php/GlobalLayerTroubleshootingGuide .

d. Installing and Testing GridRM Portlets (optional task)

An optional task is the installation of JSR-168 Portlets that provide a Web-based administrative GUI for interacting with GridRM Gateways - Note the Portlets are not required for successful EERM operation but they can be helpful for administering resources at a provider's site. Operational details can be found in the resource provider's user guide.

d.1) Download from the SORMA DVD: GridRM Portlets v 0.9.2 war file

```
/ivy/vendor/sorma-vendor/org.gridrm/gridrmPortlets/LATEST/gridrmPortlets.war
```

d.2) Pre-requisites

- Gridsphere 2.2.8 (or a later 2.2 series) installed and working.
- Sun Java 1.5 or later.
- A standalone mediator already configured and running (you need to use a standalone mediator with the GridRM Portlets. Do not try to an embedded mediator from within Tomcat or you will experience issues)
- Bi-directional firewall access between the local Portlet mediator and the mediator for any gateway that you wish to connect to.

The following Network ports need to be open:

Component	Port number (ServerSocket)	Port description	Container?
Tycho Mediator	typically 8080, but any can be used	Wide-area communication over HTTPS between Tycho mediators on remote machines, single port. We typically stick to 8080, 80, because most firewalls allow traffic to these ports to pass by default. Port must be open both ways.	Embedded Jetty
Tomcat port	Typically 80, but any can be used	Client Web browsers connect to this Tomcat port in order to log in to Gridsphere and access the Portlets	Apache Tomcat

d.3) Install the GridRM Portlets

Copy the gridrmportlets-0.9.2.war to CATALINA_HOME/webapps/ and restart the servlet container (Tomcat).
Enter the following command to enable the Gridrm Portlets.

```
touch $CATALAINA_HOME/webapps/gridsphere/WEB-
INF/CustomPortal/portlets/gridrmPortlets
```

Login to GridSphere and create a new Portlet group. The menu can be found under the Administration tab. This will allow portal users to subscribe to the GridRM Portlets. For this example we use the group name of `Resource Monitoring`. In Figure 14, the Portlet group is created by providing a group name and selecting the Portlets that should be part of the group. In this instance we only select the GridRM monitoring Portlets, but you can combine Portlets from different sources within a single group.

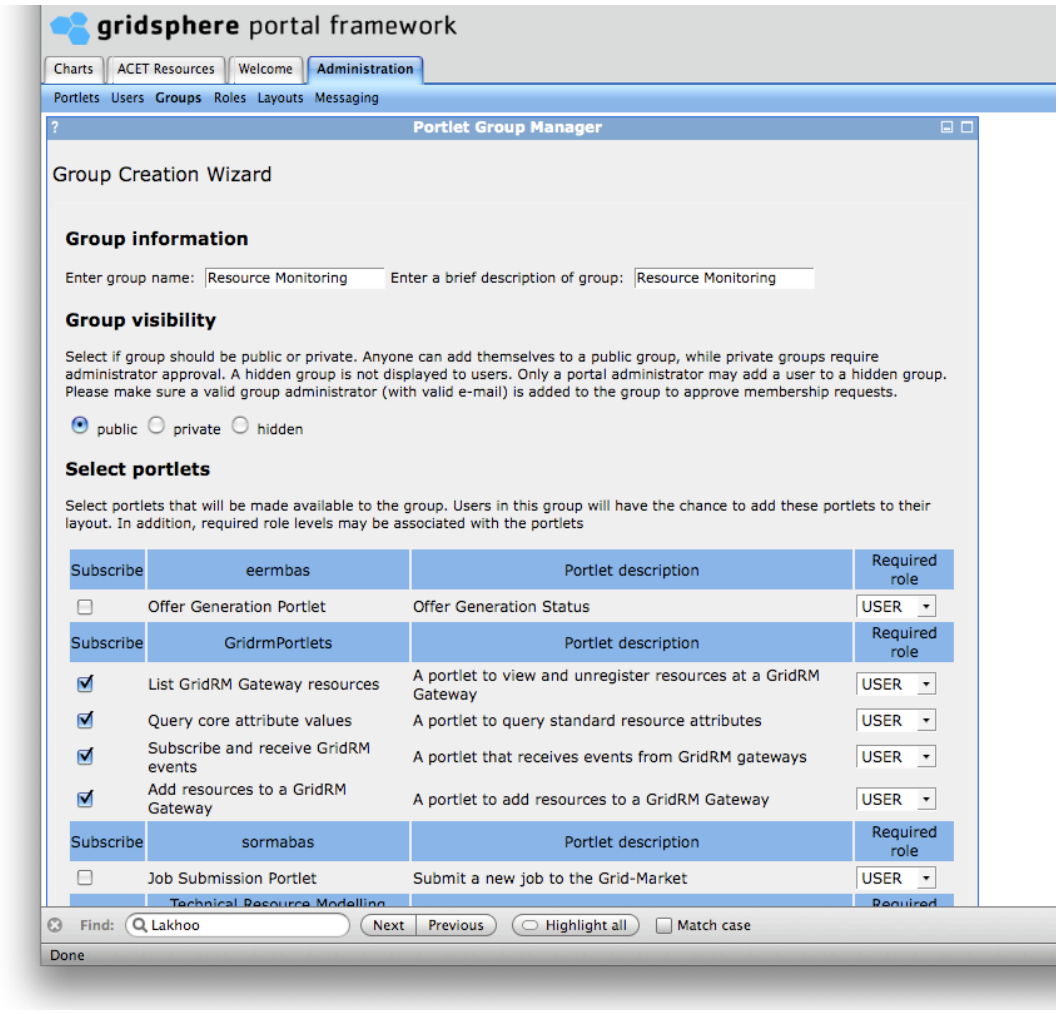


Figure 14: Portlet Group Manager

Figure 15 shows the `Resource Monitoring` group after it has been created. Note the `edit users` link: Administrators can assign particular groups to users, so that uses can access the group when they log in to Gridsphere. Further groups can be created by clicking the `Create new group` button, and existing groups can be deleted using the associated `Delete` button.

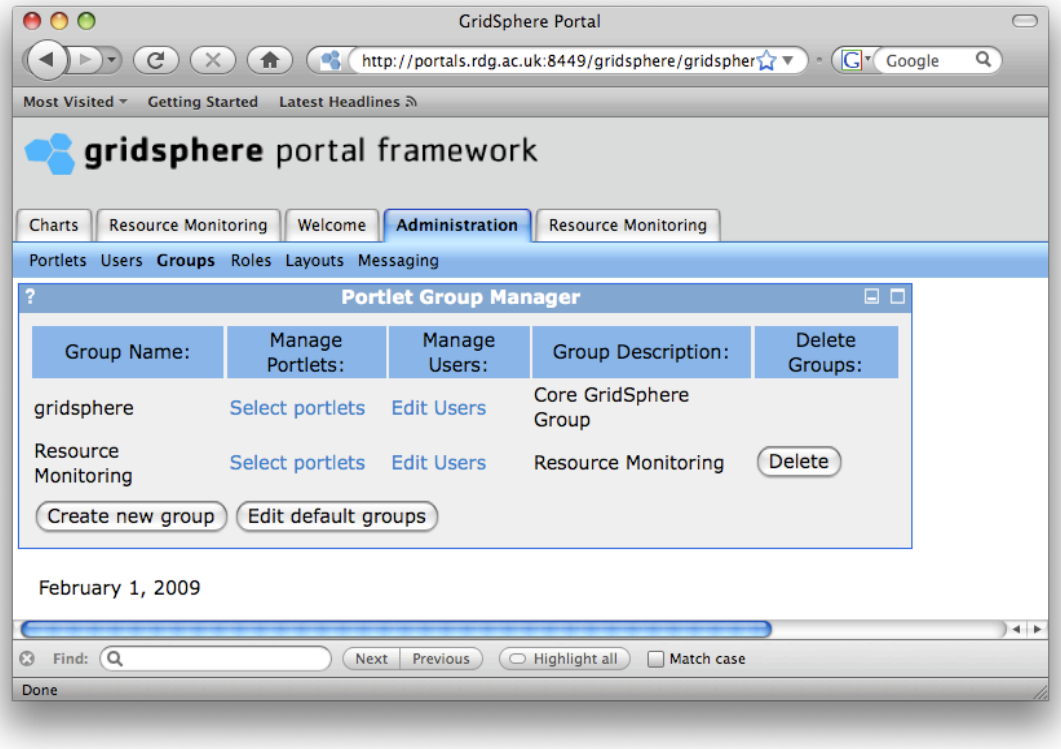


Figure 15: New 'Resource Monitoring' group created

Once the `Resource Monitoring` group has been created, users (including the administrator) can then create a new tab and select the particular Portlets that they wish to use. After logging in, users can navigate to the Welcome tab, layout option (see Figure 16) and create a new tab in which to host the Portlets they have access to (access is role based, e.g. USER or ADMIN, as alluded to in Figure 14). Notice in Figure 16 that Portlets can be laid out in a tab using 1, 2 or 3 columns: The width of the Portlets and amount of data displayed, as well as user preference, affect which column configuration is selected.

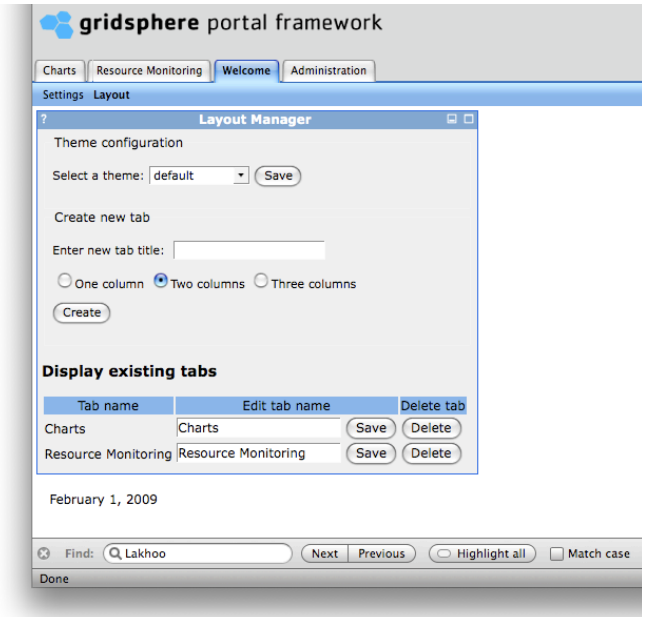


Figure 16: Creating a new tab to host the Portlets from the Resource Monitoring Portlet group

Figure 17 shows the `Resource Monitoring` tab in action: Notice the controls at the bottom of the page for adding Portlets to the tab in a user defined order.

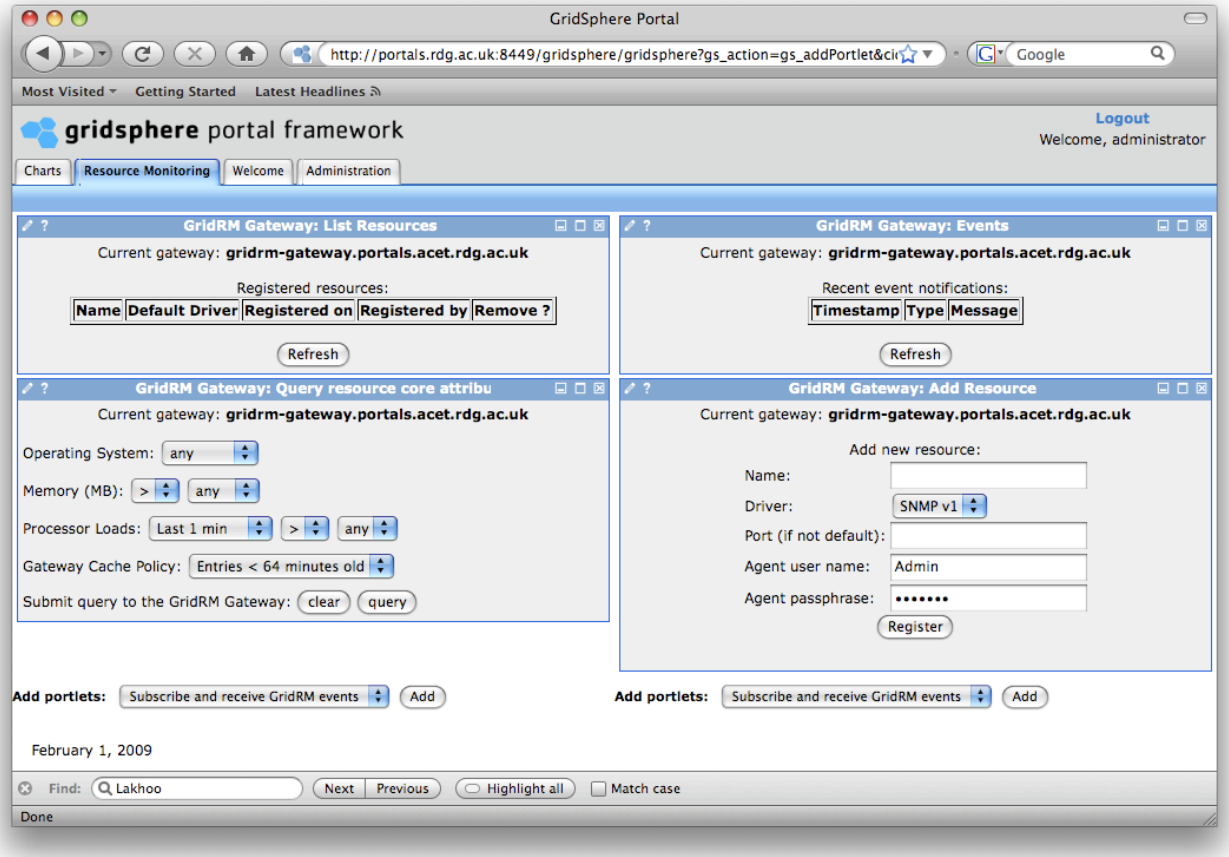


Figure 17: The Resource Monitoring tab populated with Portlets

d.4) Configure the GridRM Portlets

The resource monitoring Portlets are now installed, but before they can be used they need to be configured to connect to a GridRM Gateway. You can achieve this by entering the Portlet edit mode (by clicking the pen icon as shown Figure 18) and setting appropriate values for the gateway you want to connect to.

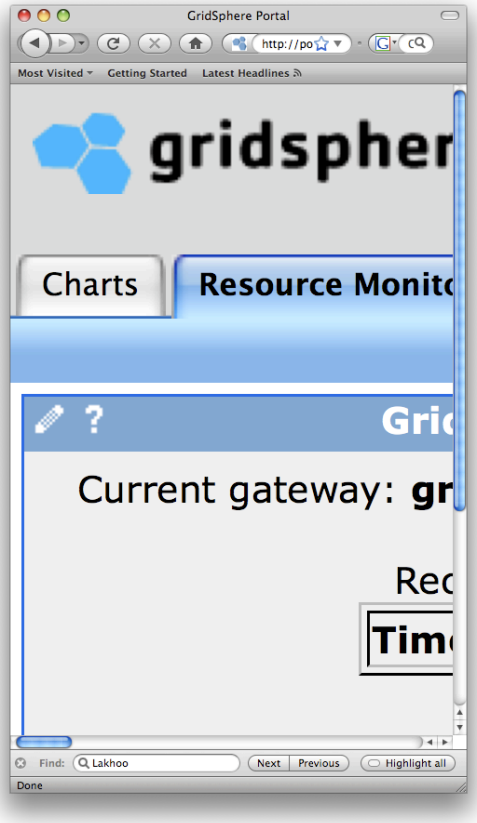


Figure 18: All Portlets have an edit mode which is accessed via the pen icon

All Portlets have an edit mode section titled 'Configure Gateway' (see Figure 19). Each Portlet can be set individually to connect to a different gateway, so you will need to edit the settings for each Portlet you wish to use:

`GridRM Gateway Tycho name`: The Tycho name of the gateway you want to connect to. This name corresponds to the `tycho.gridrm.gateway.name` property that was set in the gateway's configuration file.

`Tycho mediator socket address`: This is the socket address of the standalone mediator that you are using for the Portlets.

`Tycho mediator group name`: Set this to the group name used by the standalone Tycho mediator.

`Distinguished Name (DN)`: Your user name for the gateway.

`Passphrase`: Your passphrase.

Depending on the Portlet, the edit mode may also contain other parameters that you can set. For example, the Portlet shown in next figure has a section titled 'Event Subscriptions' where you can subscribe to receive events from the associated gateway.

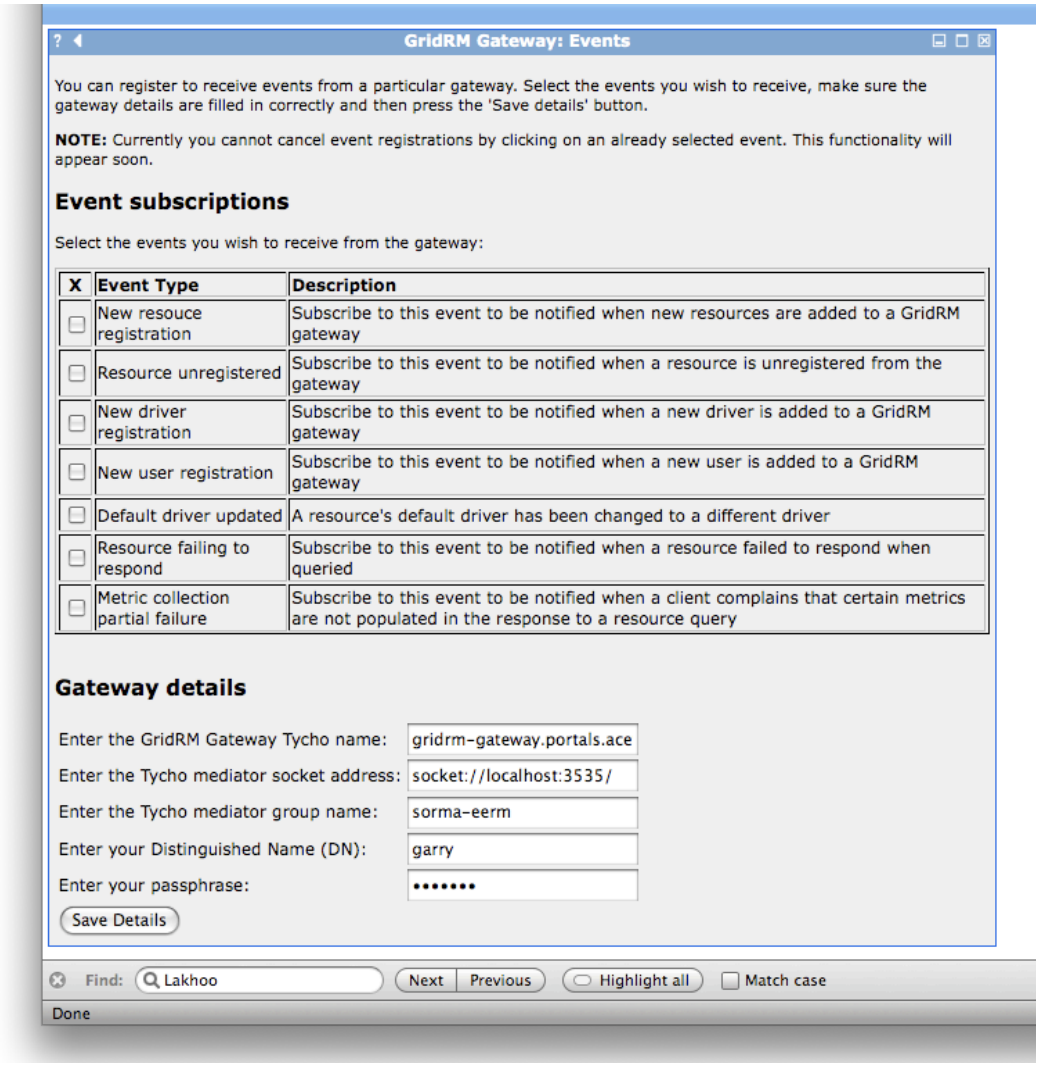


Figure 19: Configuring Portlet behaviour using the edit mode

d.5) Testing the GridRM Portlets:

A good test to check Portlet/gateway communications is to try and subscribe for events using the Event Portlet (see Figure 19). Select an event type and click the `Save Details` button. If you receive the `Initialisation of Tycho blocking API failed` error message (as shown in Figure 20) the Portlet was unable to contact a mediator. If this occurs, check that the standalone mediator is running either on the local machine or is available across the local network. Check firewall rules to/from the machine hosting the Portlet container and the machine hosting the standalone mediator.

A quick check of `$CATALINA_HOME/logs/catalina.out` will confirm that the standalone mediator could not be contacted:

```
Attempting to register with the standalone mediator at socket://localhost:3535/
with a hostname of: kat.acet.rdg.ac.uk
21:59:16.852 EVENT  Started SocketServer on 0.0.0.0:38569
Registering with Tycho registry...
21:59:16.854 WARN   ConnectException in socketSend: (java.net.ConnectException:
Connection refused) Dest: localhost:3535
An error occurred when registering with the Tycho registry
7792405484:DEBUG:(PortletLayoutEngine.java:actionPerformed:245)
```

In fact in this example the mediator had not been started. Fix the problem (in this case start the mediator) and try again.

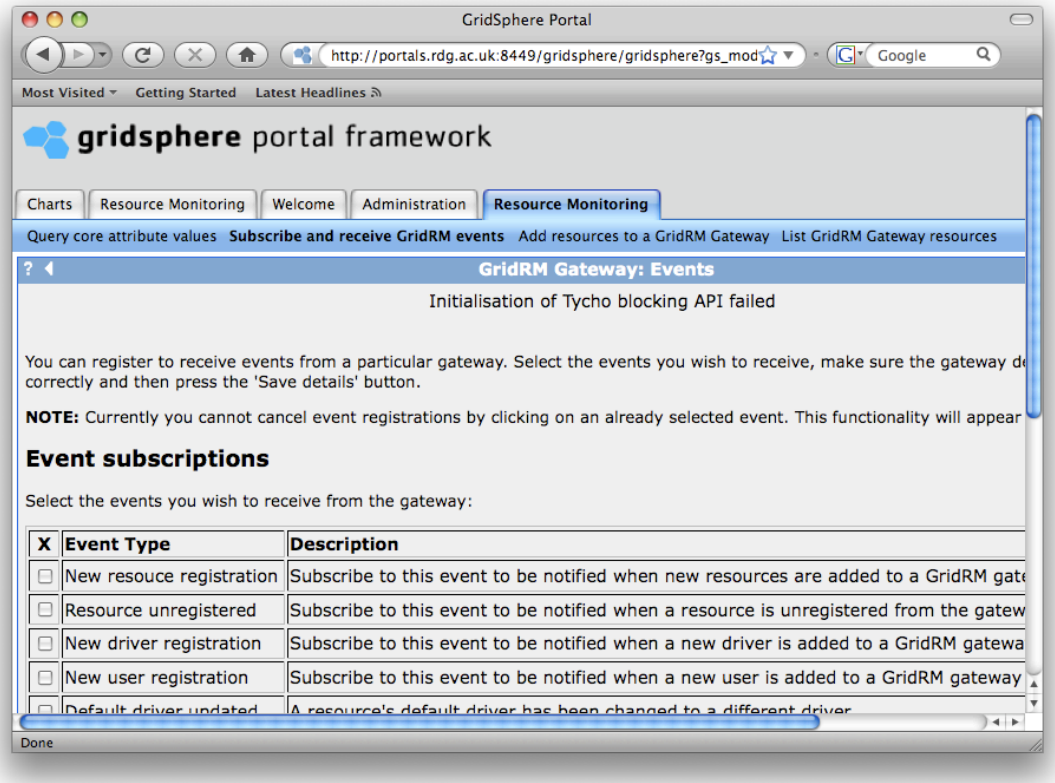


Figure 20: Initialisation of Tycho blocking API failed

After the first test passes successfully, use the `Query Core Attributes` Portlet to perform a query against a gateway. If you do not receive any results, then check the following:

- The specified gateway is running.
- Bi-directional communications between the gateway's mediator and the standalone mediator used by the Portlets.
- Check with the gateway administrator to determine mediator settings - both mediators should be in the same group).
- Check the `$CATALINA_HOME/logs/catalina.out` for signs of problems.

e. Installing and running the EERM

e.1) Pre-requirements

- Apache Ant 1.7
- Apache Tomcat 5.5 or higher
- Java 6 SDK

You should also ensure that the following environment variables are correctly configured:

```
export JAVA_HOME=/your/jdk6/path
export CATALINA_HOME=/your/tomcat/path
```

e.2) Download from the SORMA DVD EERM.war:

`/ivy/sorma/eu.sormaproject/EERM/LATEST/EERM.war`

e.3) Unpack EERM.war to $CATALINA_HOME/webapps directory.

e.4) Edit file: $CATALINA_HOME/webapps/EERM/WEB-INF/classes/eermConfig.properties, and set the next properties:

property name	description
agent.tycho.name	put some agent name for the EERM (e.g. eerm-vm.txt.it)
eerm.proxy.service	http://localhost:18080/EERM/WSProxy <-- change localhost by the IP address of your tomcat server and 18080 by the port number
gridrm.gateway.name	Put the name of the gridRM gateway. It must be the same as specified in the property called "tycho.gridrm.gateway.name" of the file server.properties in your GridRM gateway directory
tycho.mediator.group.name	some name the tycho mediator group, for example sorma-eerm.txt.it
agentservice.url	http://147.83.30.246:17567/AgentService/AgentService?wsdl <-- Change the IP and the port of the AgentService with the address of the AgentService machine to use.

e.5) Now, to run EERM, you only have to run the tomcat server:

```
$CATALINA_HOME/bin/catalina.sh start
```

f. Installation of the Resource Fabrics

f.1) Resource monitoring daemon

There are a number of different ways that resources can be monitored depending on their type and any existing agents that are present. For the purposes of this guide we will describe how to monitor using Ganglia the popular cluster monitoring tool used in many Grid installations.

First of all, you need to have installed a ganglia monitoring daemon. In Ubuntu or Debian, it's easy to install it:

```
$ sudo apt-get install ganglia-monitor gmetad
```

To start it, run as root the next commands:

```
$ gmond start
$ gmetad start
```

To check that Ganglia is running, type: `telnet localhost 8649`. You should see a large XML in the console. Keep in mind the host name (bscib12.bsc.es) in the next XML:

```
<GANGLIA_XML VERSION="2.5.7" SOURCE="gmond">
<CLUSTER NAME="unspecified" LOCALTIME="1232101290" OWNER="unspecified"
LATLONG="unspecified" URL="unspecified">
<HOST NAME="bscib12.bsc.es" IP="84.88.50.91" REPORTED="1232101271" TN="19"
TMAX="20" DMAX="0" LOCATION="unspecified" GMOND_STARTED="1232101235">
<METRIC NAME="cpu_nice" VAL="0.4" TYPE="float" UNITS="%" TN="55" TMAX="90"
DMAX="0" SLOPE="both" SOURCE="gmond"/>
```

The host name of ganglia MUST be the same that the Linux hostname. If you type the command *hostname* in the console, the output must be exactly the same (in that example, bscib12.bsc.es). If not,

you MUST change it, by .e.g. adding an entry to `/etc/hosts`, or by changing `/etc/hostname`, or by ensuring that you `DHCPCD` is configured to correctly set the hostname.

f.2) Tycho-GridSAM (for batch resources)

Tycho GridSAM provides a mechanism to bind GridSAM exposed resources to the EERM. GridSAM is a Grid middleware provided by OMMI UK, under the UK eScience programme. In SORMA we have extracted the core GridSAM functionality, which we then wrap in a Tycho connector to give us a flexible event-based front end to GridSAM. GridSAM provides plugins to interact with a range of middleware. In this example we consider a simple case to get you up and running with the SORMA system as a whole.

Download Tycho GridSAM from the DVD:

`/ivy/sorma/eu.sormaproject/TychoGridSAM/LATEST/TychoGridSAM.tar.gz`

Unpack the file. Create a new text file, call it for example, *custom.properties* and update the properties to reflect the settings you used for your GridRM Gateway and EERM. In order to utilise the Ganglia agent, you need to make sure that `gridrm.driver.type` is set to `ganglia` and `gridrm.driver.port` is either set to `0` (for the ganglia default of 8649, or set to the appropriate port number for your Ganglia daemon. An example of the config file is shown next:

```
# The name of the GridRM gateway that this instance of the TychoGridSAM associates
with
gridrm.gateway.name=gridrm-gateway.localhost

# The driver that the GridRM Gateway needs to use to monitor
# the resource that this Tycho GridSAM points to:
gridrm.driver.type=ganglia
#gridrm.driver.type=snmp
#gridrm.driver.type=gridrm_agent
gridrm.driver.port=0

#Set the tycho.mediator.url if you want to connect to a
#standalona mediator. Default is to use an embedded
#mediator.  Examples for pointing to a standalone mediator:
#tycho.mediator.url=socket://dom03-lister.acet.rdg.ac.uk:3535
#tycho.mediator.url=
#tycho.mediator.url=socket://10.0.2.200:3535

# The tycho mediator group name must be set correctly in order
# for the embedded mediator to work. Make sure you set this value
# to the same group name that is being used by the EERM, GridRM Gateway,
# and Custom GridRM Agent
tycho.mediator.group.name=

# Do not change this the following value
tycho.gridsam.suffix=_gridsam
```

To run Tycho-GridSAM, just type:

```
java -jar TychoGridSAM.jar -properties=custom.properties
```

f.3) Tycho-Services Connector (for Web Services)

The Tycho-Services connector is used to bind Web Services to the EERM. First, you need to have running your Web Service in your application container (Tomcat, Apache, Jboss...). This is a very basic operation that will depend on your service, so there are not instructions for this.

Download the Tycho-Services Connector from the DVD:

`/ivy/sorma/eu.sormaproject/TychoServices/LATEST/TychoServices.tar.gz`

Unpack it and create a new text file, call it for example, *custom.properties* and add the next properties:

```
gridrm.gateway.name=gridrm-gateway.upc.es
tycho.mediator.group.name=sorma-eerm.upc.es
```

The values of these properties MUST be exactly the same as the properties with the same name in the GridRM gateway and previously described eermConfig.properties file.

To run Tycho-Services Connector, just type:

```
java -jar TychoServices.jar -properties=custom.properties -
url=http://your.service:port/service/path
```

Change *http://your.service:port/service/path* by the URL to access locally to your service.

Your machine is ready to accept and serve jobs if you connect via web to the EERM and see your machine in the main panel.

g. Ready

Your machine is now ready to accept and execute jobs if you connect via web to the EERM and see your machine in the main panel:

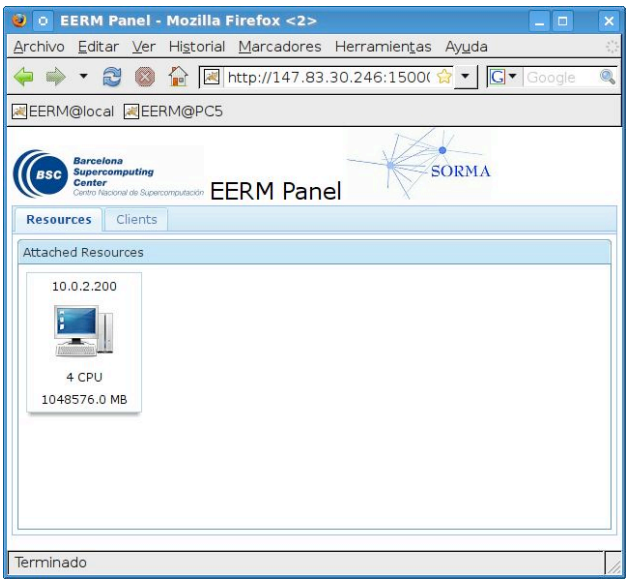


Figure 21: EERM main panel

3.3. *Provider's User Manual*

This section describes how Resource Provider should use the SORMA components in order to be able to trade their resources on the SORMA Grid market
The components involved are:

- Intelligent Tools – to model resources and bidding strategies, and to submit offers
- EERM – to monitor job executions (resource usage, etc..)

3.3.1. **Resource Modelling GUI**

The Technical Resource Modelling Portlet (TRMP) is used to create JSDL-based resource definition files, so to describe a specific host system (Figure 22):

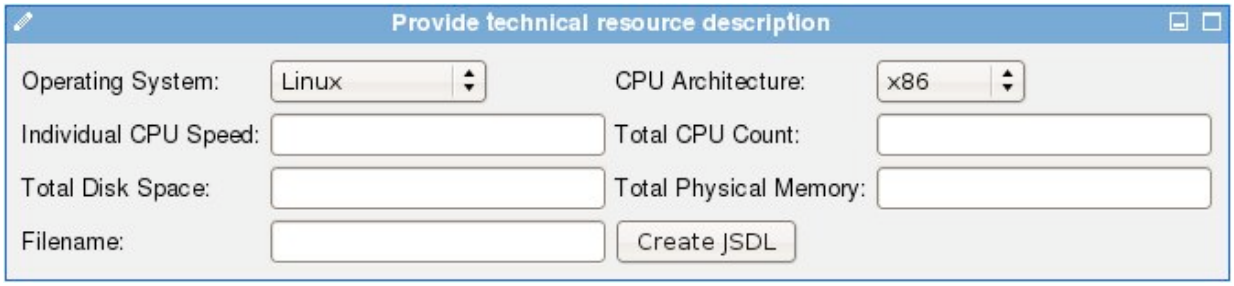


Figure 22: Standard view of the Technical Resource Modelling

The values for Operating System and CPU Architecture are chosen via drop down menus, CPU Speed, CPU Count and Disk Space take integer values. Filename represents the name of the JSDL file you want to create, as shown:

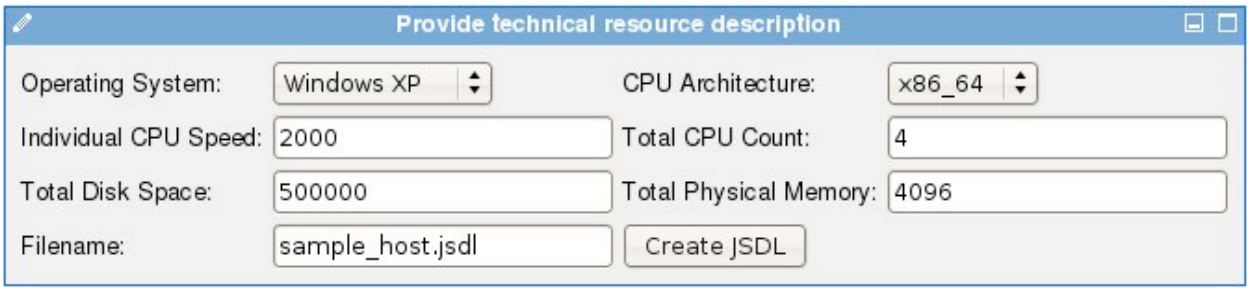


Figure 23: Sample values

A click on the Create JSDL button creates the document.
After a document was created it can be viewed and opened for further editing. To open a document click on the small pencil-shaped icon in the upper left corner of the Technical Resource Modelling view. The state of the will change to the view shown in Figure 24:

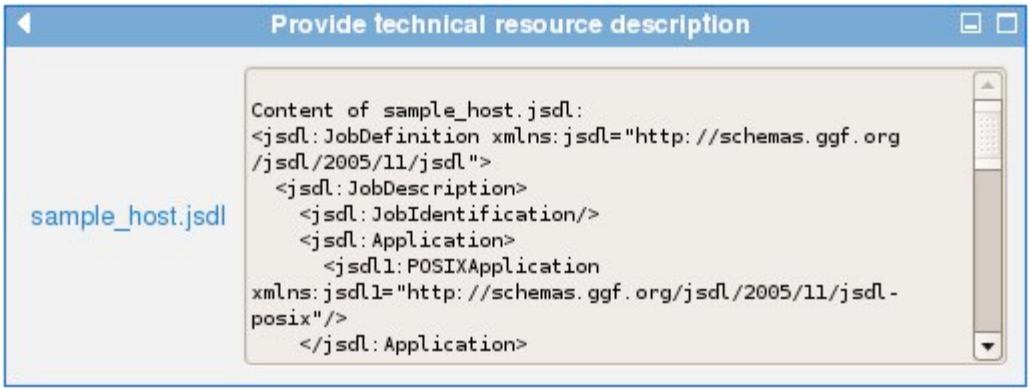


Figure 24: JSDL source view

On the left hand side of the view all files contained in the JSDL Resource directory of the TRMP are listed (currently sample_host.jsdl is the only file). If you click the name of a specific file, its content will be shown in the window on the right side of the view. Also the file will be selected for further editing. If you want to edit the values of a selected file just click on the small arrow icon in the upper left corner and the Portlet will switch back to the base view with the values loaded from the file to the corresponding fields.

3.3.2. **Offer Submission GUI**

The *Resource Modelling* (section 3.3.1) and provider (*Offer Submission*) Portlets support the technical description of the offered resources and the expression of the economic preferences. The Portlets are part of the intelligent tools that complement the OfferGenerator (BidGenerator and OfferGenerator implement a similar behaviour and thus we implemented one bidding framework for both cases, called BidGenerator).

The usage of Portlets describes the case when providers want to use a Web GUI interface in order to prepare and submit offers for their resources. The Portlets are implemented and deployed in the portal framework *GridSphere*[11].
The process of manual offering of computing resources to the SORMA-Market contains several steps, supported by the implemented provider Portlets.

Step 1: The first step is the technical description of a computing resource, (section 3.3.1) which result in the creation of a JSDL document, *res1.jsdl*.

Step 2: The description of the economic preferences is supported by the *Economic Resource Description* Portlet (Figure 25). In addition to the technical resource description (*res1.jsdl*), the provider enters its economic preferences like when to submit the offer (*Date to submit*), the duration for which the resource will be offered (*Provided duration*), preferred *bidding strategy*, *reservation price* (minimum requested price) and the bid's "Time to Live" (*Bid validity*).

[11] http://www.gridsphere.org/

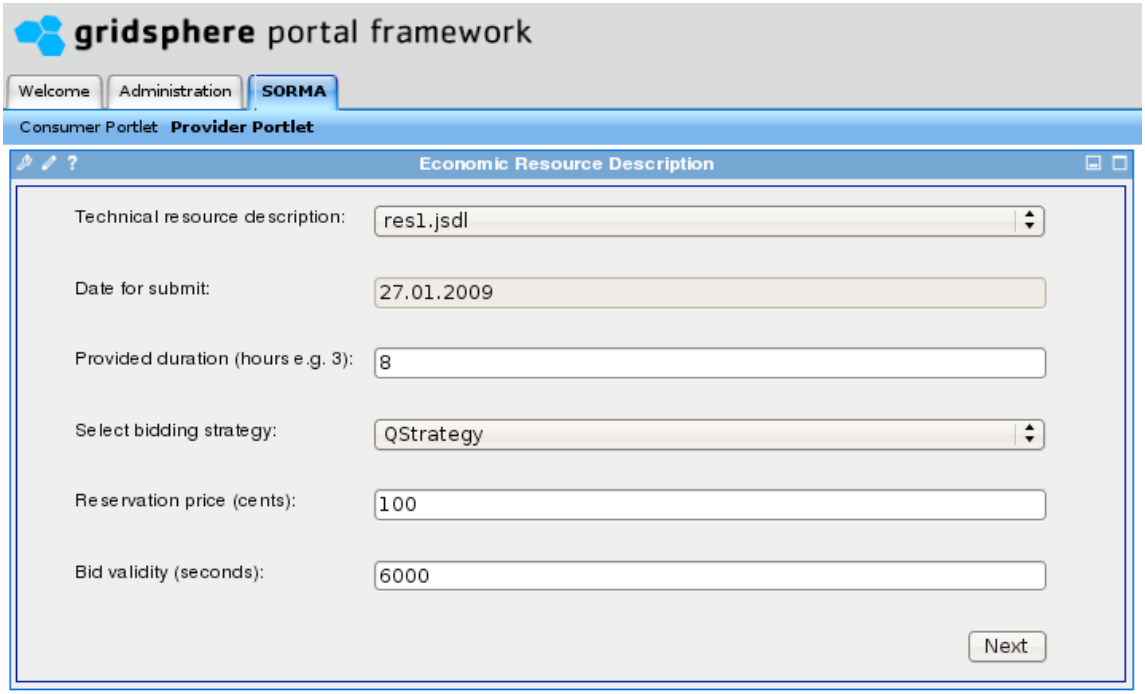


Figure 25: Economic description of the offered resource

Step 3: The entered preferences are shown one more time (Figure 26) before the provider submits the offer request to the BidGenerator (section 3.2.1), which initiates the negotiation process based on the preferences.

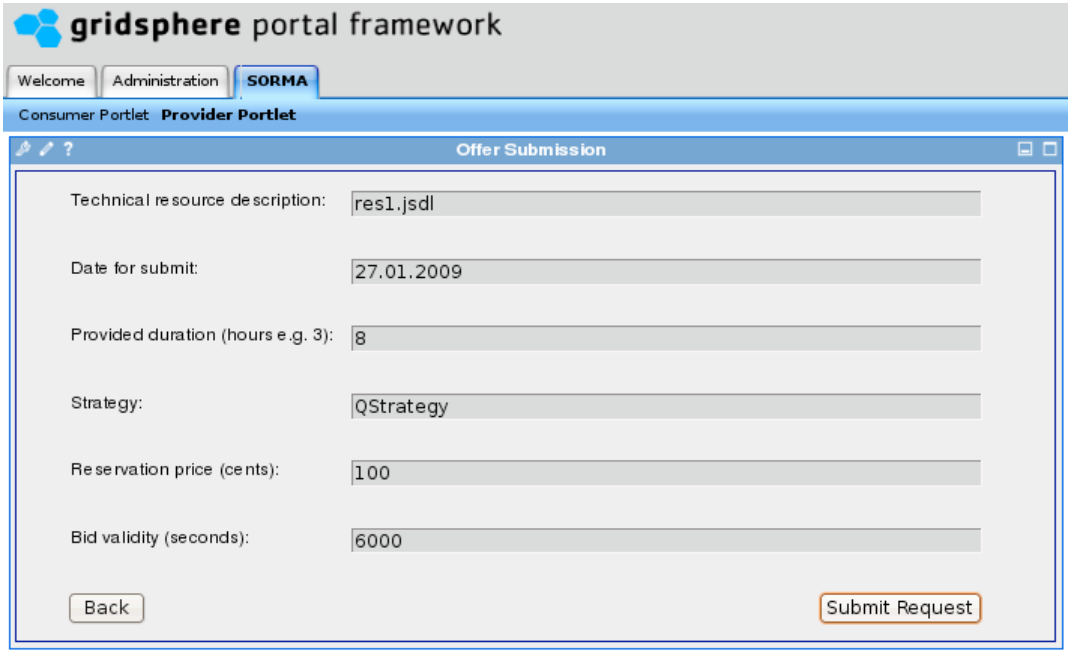


Figure 26: Submission of the offer-request to BidGenerator

Step 4: Figure 27 shows the result of the offer request. If there is an allocation it shows the economic data like the reserve price, the generated bid, the calculated payment by the market, allocated job and consumer.

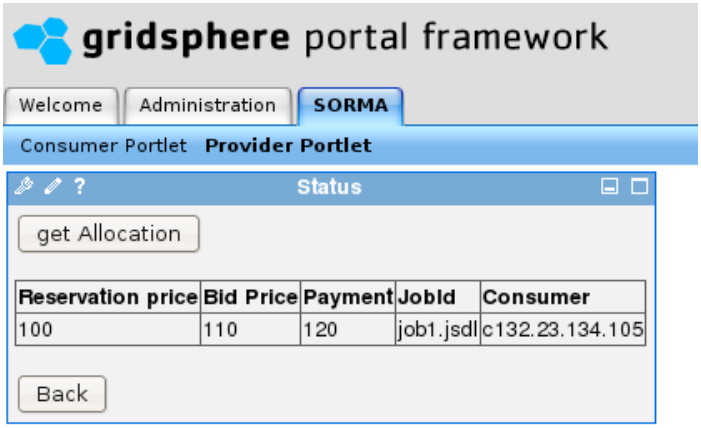


Figure 27: Status information

3.3.3. **EERM GUI**

The EERM GUI offers a control panel that can support three basic functionalities:

- Resources list
- Clients information
- Economic policies

Figure 28 shows the aspect of the Resources Panel. All the attached resources are listed, with some related information. The left icon of the image represents a resource that executes a web service, and the right icon represents a batch resource.

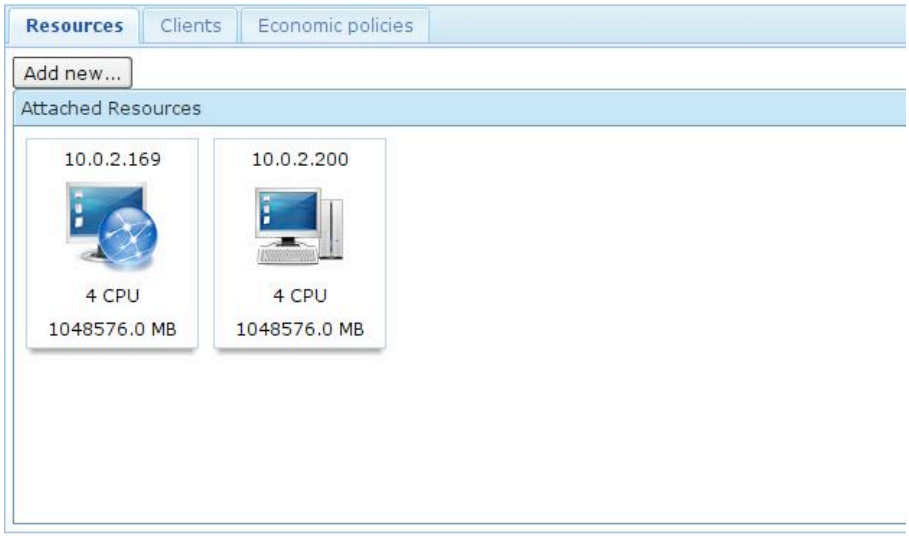


Figure 28: EERM resources list

If you click the "*Add new...*" button, a window (see Figure 29) for adding a new virtualized resource to the EERM will be displayed. You only have to specify the desired properties and the EERM will automatically contact the Virtualization Manager for creating a custom Virtual Machine.

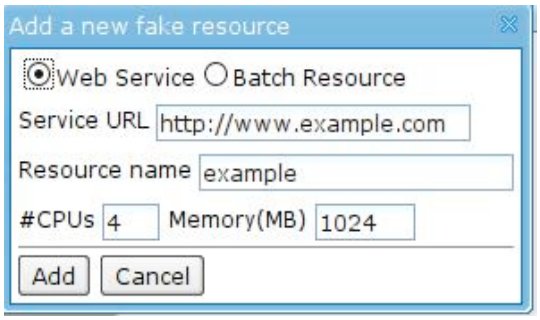


Figure 29: adding resources to EERM

If you click the icon of any resource with the left button, it will appear a contextual menu (see Figure 30) with some actions to perform upon the resource.

Figure 30: managing virtual machines

The actions that can be performed are:

- **Reserve Resource**: a small form (Figure 31) will appear to allow the EERM administrator to manually perform a reservation. Reservations can be specified as fixed points or as intervals, the start and end date, and specify one or more resources to reserve (currently, CPU and RAM memory).

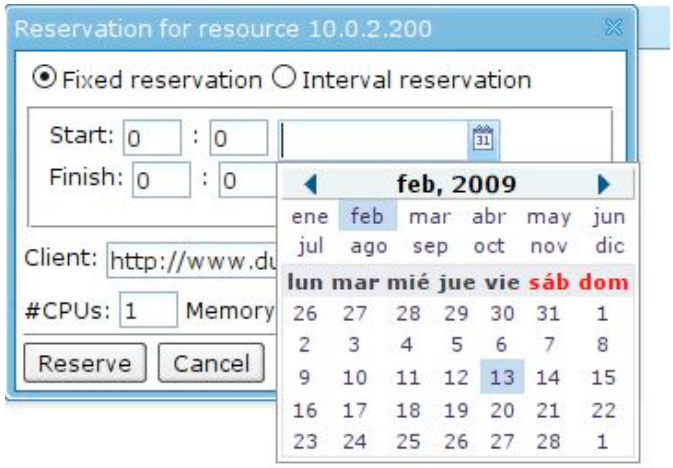


Figure 31: reserving resources manually

- **Visit URL**: only for services. This enables the user visit to the URL endpoint of the service using the EERM proxy.
- **Send test job**: only for batch resources. The administrator can send a simple ray-tracer job to check that the resource fabrics are working correctly. If the job is successful, the user will see the result (a generated image as shown in Figure 32).

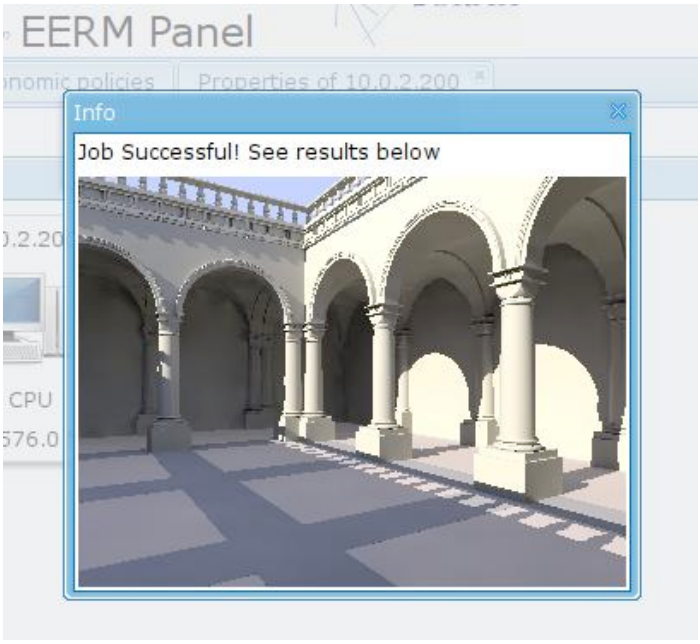


Figure 32: testing batch resources

- **Show properties**: this opens in a new tab (an example is shown in Figure 33), which is added to the general panel of the EERM. In this tab, the user can see some information about the resource:
    - System description
    - Monitoring information (only CPU at the moment)
    - Timetable with the amount of resources reserved (only CPU and memory at the moment).

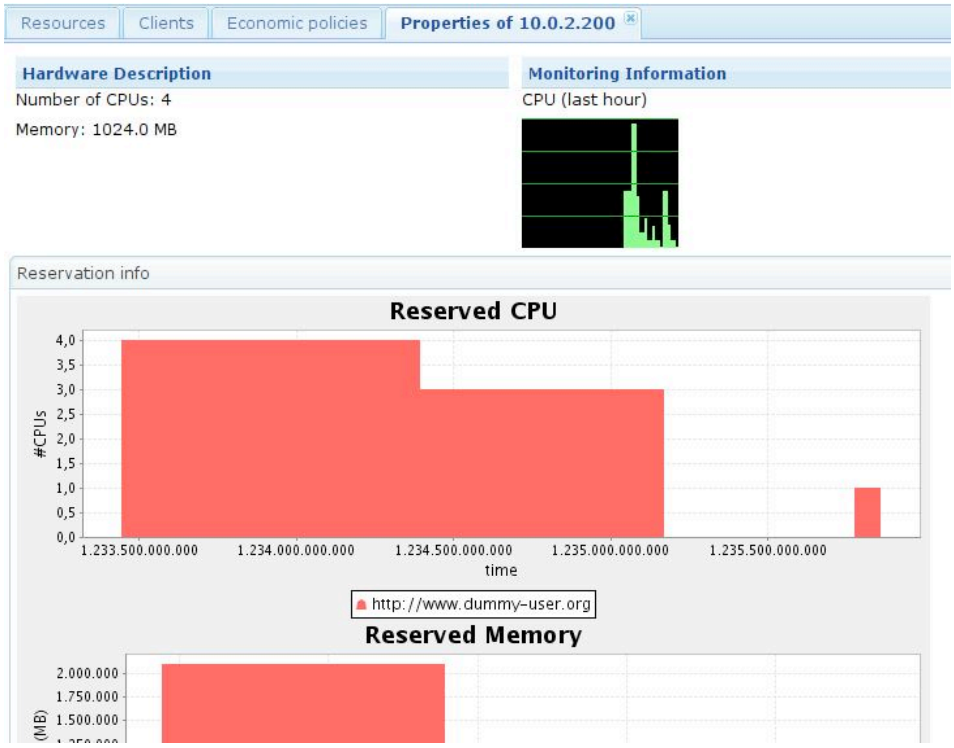


Figure 33: showing resource properties

The other general section of the EERM panel is the one related to the clients' information (Figure 34). Here you can see the client identifier, its reputation, and its classification. The two last columns are useful for applying some economic policies.

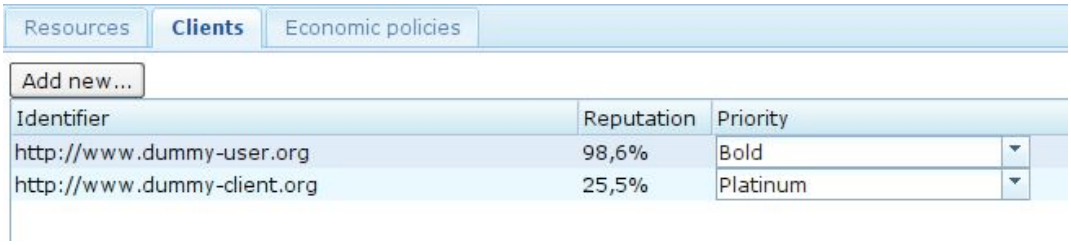


Figure 34: clients' properties view

Figure 35 shows the third section, which allows the administrator to specify the economic preferences of the EERM, for example the goal of the policies (revenue maximization, weight workload etc.), the negotiations strategies (with varying degrees of aggressiveness), and the application of the client classification.

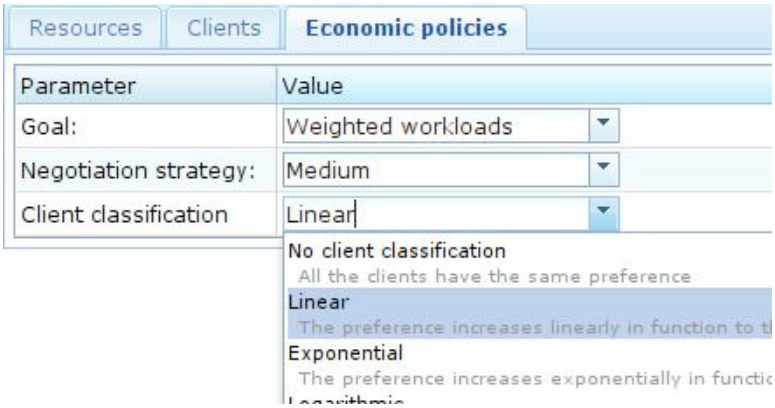


Figure 35: specifying preferences for resource policies

4. Resource Consumers Manuals

4.1. Introduction

A consumer who wants to access resources from the SORMA market is required only to install and run the consumer-side Intelligent Tools. These tools enable consumers to specify resource requests to execute a given job and to submit bids to the SORMA Market that will return one or more providers matching the selection criteria. The same tools allow enable the submission of the job to the selected Provider and to access the result of the execution. These tools provide a user interface, but it is also possible for the end-user to by-pass the standard interface and to write a custom SORMA-client application using the SORMA APIs.

4.2. Intelligent Tools Installation and Configuration Guide

The Intelligent Tools consist of the components **Consumer Preferences Modelling**, **Demand Modelling** and **BidGenerator**.

The Consumer Preferences Modelling component provides a message format for describing economic and technical preferences. The technical and economic preferences are specified in **EJSDLPrivate** templates, which are stored locally and can be individual for each application. Each time an application needs a further resource, it invokes the **BidGenerator** Web services through the submission of an EJSDLPrivate document.

The **Demand** component offers a Web-based GUI (Portlet) to enable the simplified description of technical requirements for jobs, which can be imported and exported in the JSDL data format.

These components are comparable to the Providers' Intelligent Tools, so installation instructions are exactly the same: it is possible to refer to section "3.2.1- Provider-side intelligent tools". The only difference to be reported is in the deployment of the Technical Resource Portlet. Deploy the Technical Resource Portlet and *Consumer Portlets for Bid Submission* as described in section 3.2.2 d).

Copy the war-files of the *Technical Resource Portlet* and *Consumer Portlets for Bid Submission* to CATALINA_HOME/webapps/ and restart the servlet container (Tomcat). Tomcat will extract the webapps in a directory with a name like *technicalResourceModeling* and *consumerPortlets*.

Enter the following command to enable the *Technical Resource Portlet* and *Consumer Portlets for Bid Submission*:

```
touch $CATALAINA_HOME/webapps/gridsphere/WEB-
INF/CustomPortal/portlets/technicalResourceModeling
```

and

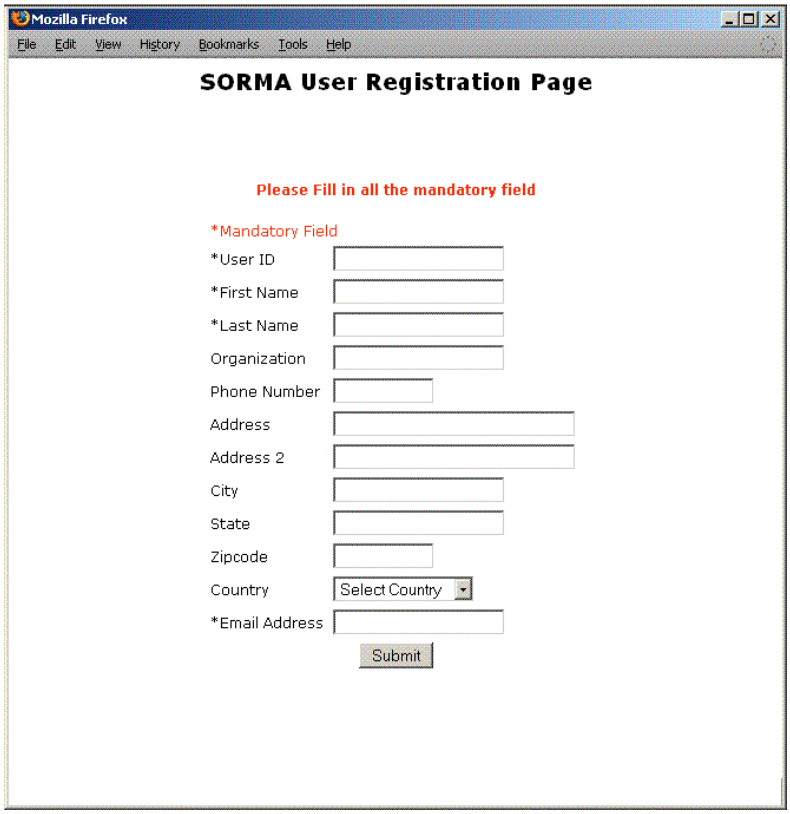
```
touch $CATALAINA_HOME/webapps/gridsphere/WEB-
INF/CustomPortal/portlets/consumerPortlets
```

4.3. *User Manual*

This section explains how to use the SORMA GUI (Intelligent Tools) and API

4.3.1. **User Registration**

For new users that want to apply to join the SORMA market, they need to first apply for a SORMA account. To do so, they need to use a web browser and go to the URL for the SORMA user registration. Going to the URL displays a web page as follows:



User has to register by filling out the form with their personal particulars. All fields that are marked with '*' are mandatory and therefore cannot be left blank. User can choose to use a preferred user ID but subjecting to availability, another user ID may be assigned instead. Once the form is completed, submit the application by clicking on the submit button. Doing so will send the application information to a SORMA administration who will then validate the application information.

4.3.2. **Intelligent Tools GUI**

The user can use the Intelligent Tools GUI to specify a job description to an existing JSDL resource file. The standard view of the section is shown in Figure 36.

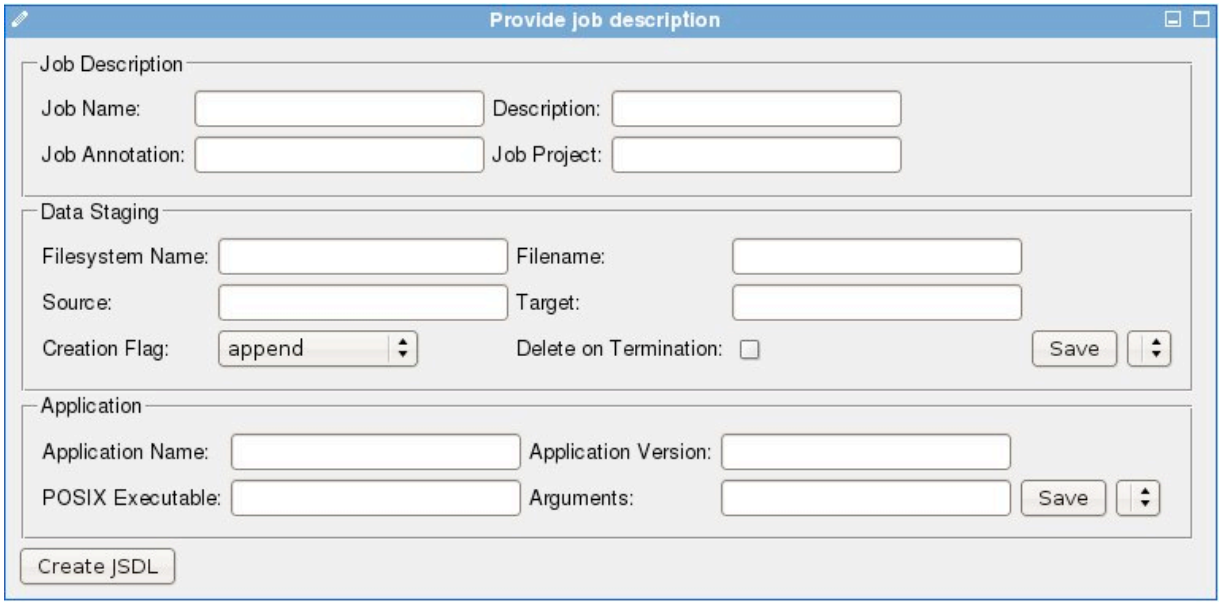


Figure 36: Standard view of the Job Description section

In order to add a job description to a specific JSDL file you first have to open the file in the job description section. To do this click on the pencil shaped icon in the upper left corner and the file selection view will open as seen in the technical resource section. Select a file and its content will be shown in a window as shown:

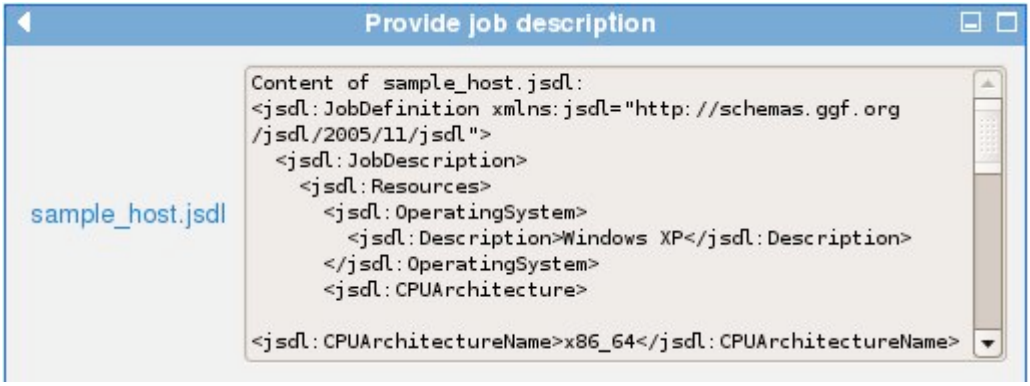


Figure 37: File selection view with sample file selected

To return to the edit view click on the arrow icon in the upper left corner of the window. The Portlet will now return to the previous view with a file selected for further editing. You can see the name of the file you are currently editing on top of the Job Description frame (see: Figure 38).

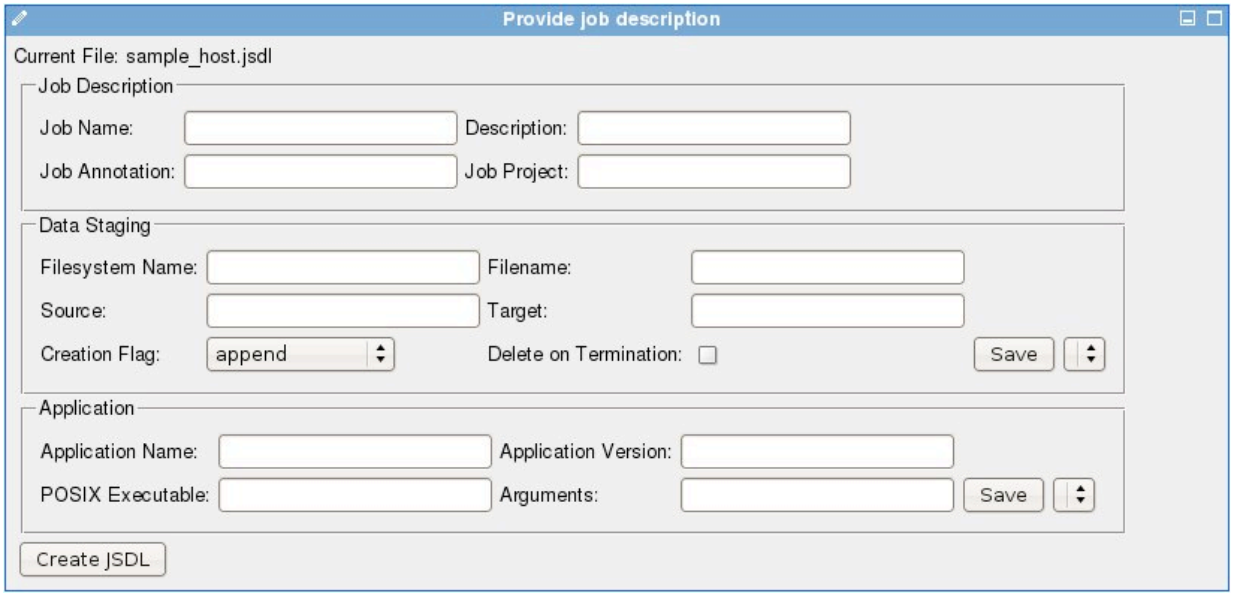


Figure 38: Standard view with file selected

To add job description information fill in the corresponding fields of each frame. You can add only one Job Description but multiple Data Staging an Application elements. Therefore you have to save each Data Staging and Application element individually by clicking on the corresponding 'save' button. After clicking a save button the element will be listed in the drop down list to the right side of the button. When you have entered all information you can create the JSDL file by clicking the 'create JSDL' button. The Portlet will then safe the file and return to standard view with no file selected.

Step 2: The description of the economic preferences is supported by the *Job Economic Description* Portlet (Figure 39). In addition to the technical job description (*job1.jsdl*), the consumer enters its economic preferences like when to submit the offer (*Date to submit*), the duration for which the resource is required (*Requested duration*), preferred *bidding strategy*, *valuation* (maximum willingness to pay) and the bid's "Time to Live" (*Bid validity*).

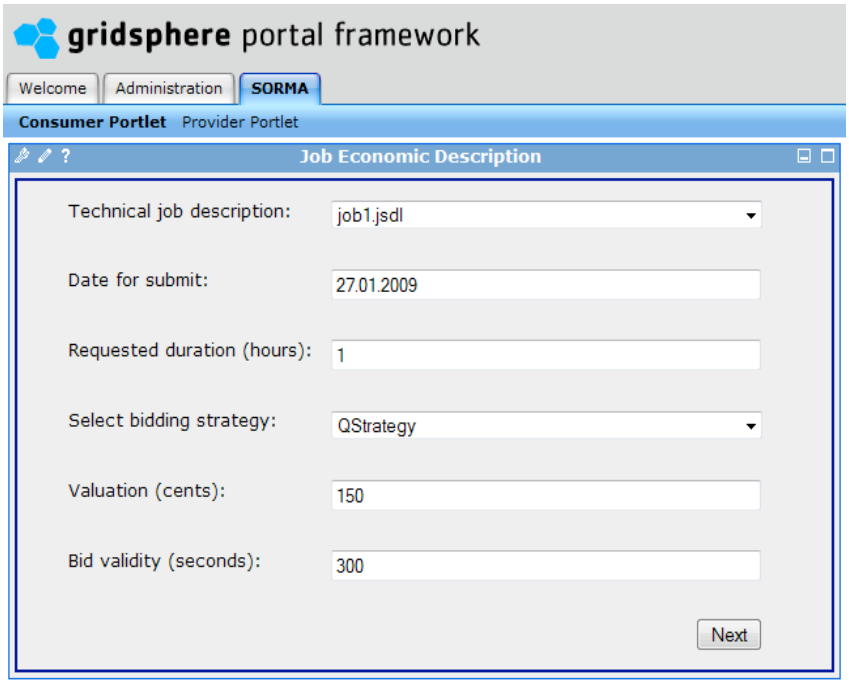


Figure 39: Economic description of the job

Step 3: The entered preferences are shown one more time (Figure 40) before the consumer submits the bid request to the BidGenerator (section 4.2), which initiates the negotiation process based on the preferences.

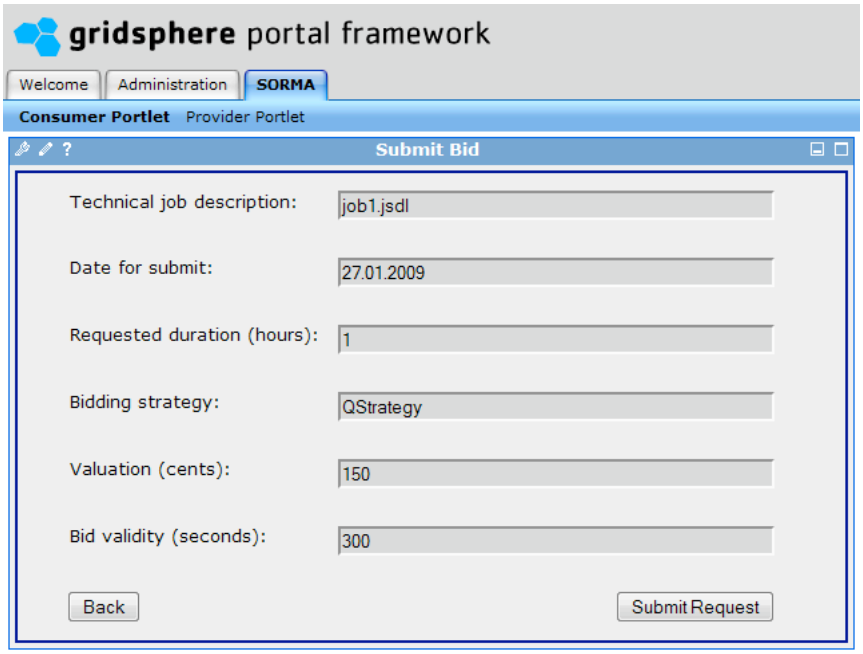


Figure 40: Submission of the bid-request to BidGenerator

Step 4: Figure 41 shows the result of the bid request. If there is an allocation the economic data for example the provider, resource reference, expected completion time, average resource utilization, valuation, bid price and payment is displayed. Finally, depending on the executed market mechanisms, the market is executing the allocation and is responding to the consumer (over BidGenerator) with the target provider resource, where to submit the job. However, there exist also market mechanisms, which respond with a bundle of offers to a given consumer request and leave the allocation decision to be done by the consumer's BidGenerator, based on the submitted consumer preferences.

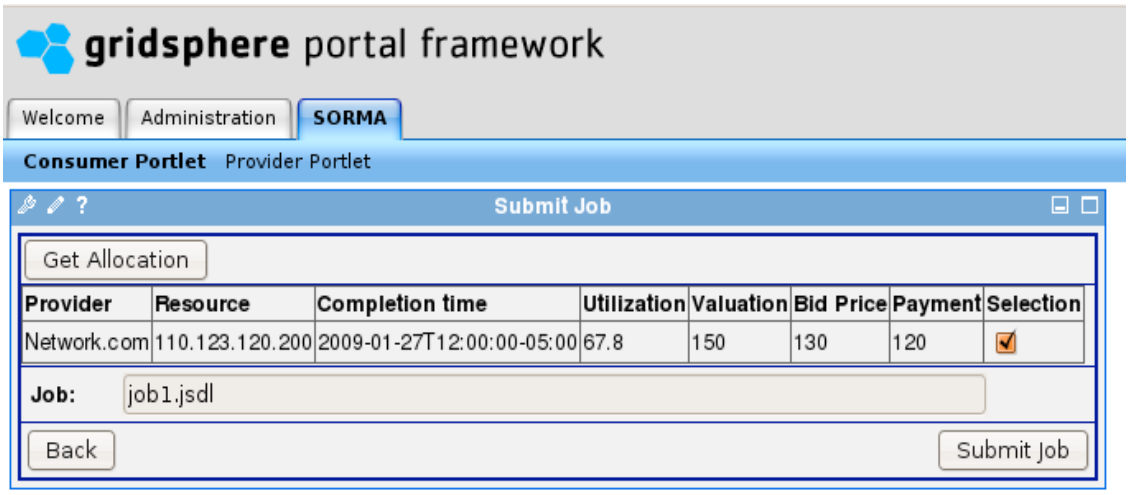


Figure 41: Status information

4.4. Consumers' Developer Kit

This section describes how end-users can build or integrate their own application with the SORMA market and interface it to Resource Providers, using the SORMA API and Messages.

4.4.1. SORMA API

SORMA API can be grouped into four main logical areas:
a- login API
b- Bid Submission API
c- Payment API
d- Job Submission & Monitoring API

a. Login API

The Login API provides a programmatic way of authenticating to the Security service and retrieve the SAML assertion. Before starting the authentication process, the user's credential has to be created like the following:

```
Credential cred = new Credential();
BasicAuthenticationCredential bac = new
BasicAuthenticationCredential();
bac.setUserId("jdoe");
bac.setPassword("changeme");
cred.setBasicAuthenticationCredential(bac);
```

The authentication can then be carried out by invoking the following methods:

```
String uri = "https://myhost:8443/sorma-security/SecurityManager";
AuthenticationClient authClient =
        new AuthenticationClient(uri,cred);
SAMLAssertion saml = authClient.authenticate();
```

If the authentication is successful, a SAML assertion will be return by the service. This SAML assertion has an expiry time and is a proof that the user has been authenticated. At any time in its validity period, the SAML assertion can be presented to the Security service to exchange for a Grid proxy credential.

b. Bid Submission API

In order to request or provide resources in an automatic way, the application providers (consumers) as well as the resource providers will use the BidGenerator's Web service interface:

```
submitBid(Credential userCredential, EJSDLPrivate ejsdlPrivate)
```

The user credentials like certificate, user name and password are specified in the Credential object, where the bid-requests is submitted in form of an EJSDLPrivate message document, described in next section

c. Payment API
The API specified here is provided by the Contract Management Client Interface.

Payment actions are carried out by invoking the following method:

PaymentResponse makePayment(PaymentDetails paymentDetails)

The PaymentDetails message document encapsulates the information required by the SORMA Payment Component to instigate a monetary transaction. The consumer does not supply the price here, as this is calculated by the SORMA Contract Management Component so that any SLA-related violations, which may have occurred, can be considered.

The invocation of this method will return a PaymentResponse message document, which describes one of three possible outcomes of the transaction. Namely:

1. Success
2. Failure
3. Not Required

If the payment was successful the response acts as a receipt of the payment, detailing the amount paid and when. If the payment was unsuccessful the response will contain information describing why the payment failed. In some rare circumstances a payment will not be required; this will only occur if the calculated price is zero, which in turn can only occur if all terms in the SLA were violated.

Further details of the Payment protocol are presented in section 4.6.3

d. Job Submission & Monitoring API
The APIs provided by the EERM are:
WSJobManager: this service implements the functionalities related with the batch jobs.

- **sendJob**: sends a job for being executed in the resource fabrics
  - Parameters
    - Identifier of the resource acquired to execute the job
    - JSDL with the job description
  - Returns: the job identifier or null if the job can not be executed

- **getJobStatus**: gets the status of a job
  - Parameters
    - Identifier of the resource that is executing the job
    - Job identifier
  - Returns: the status of the job (running, cancelled, finished, etc…) and a short explanation of the status

4.4.2. SORMA Messages

In the field of Grid-based scheduling there are several standardized description languages, which we want to adopt in our scenario. Prominent examples are the Job Submission and Description Language (JSDL) (Anjomshoaa et al [2005]), GLUE-Schema (Andreozzi et al [2008]), Common Information Model (CIM) (DMTF [2008]) and WS-Agreement (Andrieux et al [2007]). JSDL and GLUE-Schema are standard and more general resource description languages, currently used in Grid-Middlewares for the technical description of provider resources and technical requirements of the consumer jobs. CIM is a resource description model that aims to describe computing systems and their services in more

detail. WS-Agreement is an OGF-standard web services protocol for negotiating SLAs between two parties, designed for and applied mainly to bilateral SLA-Negotiation mechanisms rather than to auctions. Furthermore, WS-Agreement does not offer economic elements for auction-based bidding in the level of detail desired like specified in the following.

JSDL, GLUE and CIM aim to support the description of technical preferences for computing resources. The missing economic data should be compensated for via the provision of well-defined economic extensions E*+JSDL= EJSDL*.

The aim of the *SORMA Message API* is to provide a central API for all the messages between the SORMA components like Applications, EERM, Trading Management, Market Information System, Contract Management and BidGenerator.

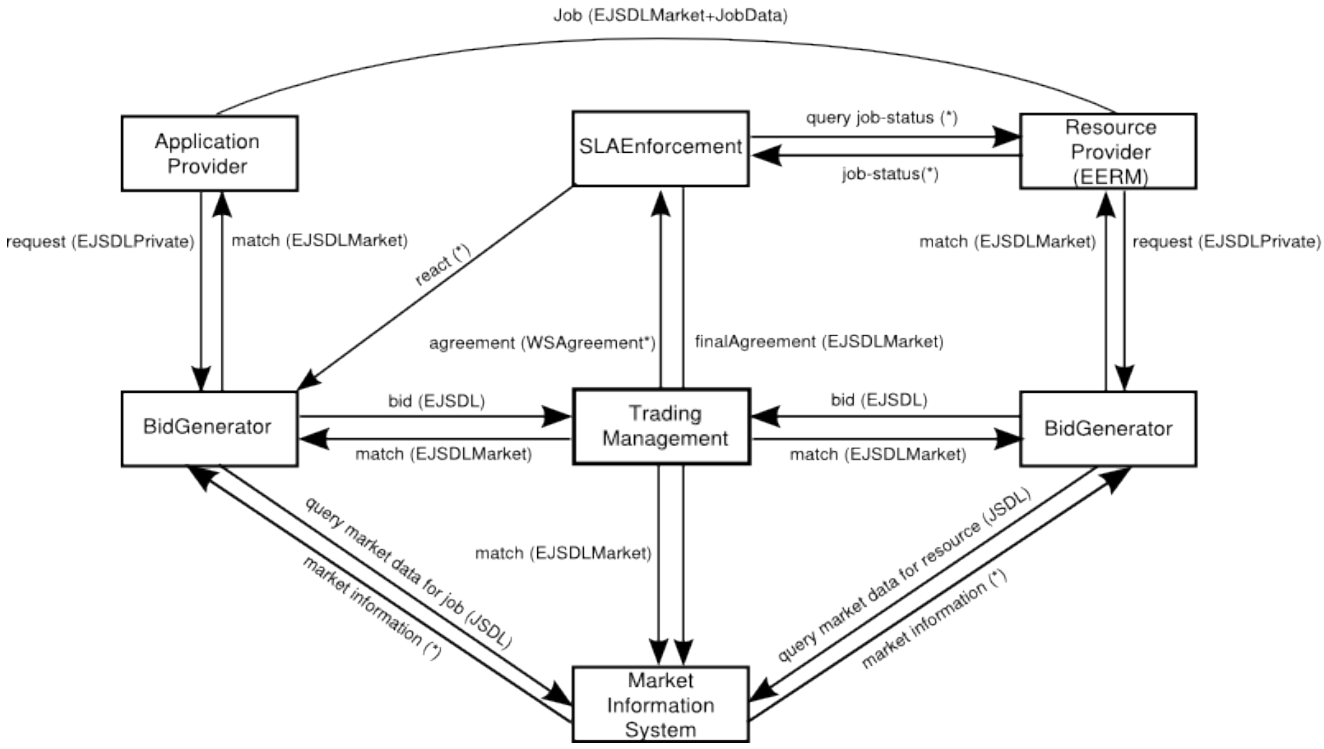


Figure 42: Message formats between the SORMA components

The main message formats produced and exchanged during the negotiation processes in SORMA are JSDL, EJSDLPrivate, EJSDL, EJSDLMarket and WS-Agreement

JSDL:
The plain JSDL message format, as proposed by OGF, implements the standard JSDL data format. In additional to the standard JSDL we added advanced reservation facility in form of start and end times to support providers which offer advanced resource reservations.

EJSDLPrivate:
The EJSDLPrivate message format extends EJSDL with additional category of *PrivateData*, which consist of private information like *valuation* and *strategy*, reported by the consumers and providers to the BidGenerator (see Example 1). This information remains private and is only considered by the bid generation processes of *BidGenerator*.

EJSDL:
The economically extended JSDL, called also EJSDL, extends the standard JSDL with the economic category Bid, which adds economic parameters in order to support the bidding process. The EJSDL-message format is used to describe the bid/offer messages send from the BidGenerator to the TradingManagement (see Example 2).

Economic extensions, in element <Bid>:

- type - the type of bid message, "bid", "offer", "match"
- participant - unique identifier of the consumer or provider
- bidPrice - the generated bid price of the consumer or provider
- timeout - the time in milliseconds a consumer or provider bid is valid in the order book
- duration - the (upper bound) duration in milliseconds for the provided or requested resource
- serviceType - the type of the requested service, batch job or WebService
- paymentType - the type of payment, before or after job execution
- currency - currency
- penalty type contains the applied penalty function - functionName and normalizationConstant

EJSDLMarket:
The EJSDLMarket message format defines an additional category *MarketMessage* for describing the market data like *clearing price* and *contractId*, which is created on match by the TradingManagement. The EJSDLMarket message is than submitted back to the target consumer and provider over the BidGenerator component (see Example 3)

Elements of <MarketMessage>:

- clearingPrice - The specified monetary value assigned to an artifact on market clearing, also market-clearing price. This price is determined by the auction, based on the bid and offer process of providers and consumers interested in trading the artifact.
- contractId - the id of the contract between a provider and a consumer
- bidId - the id of the bid
- offerId - the id of the offer
- consumerId - the unique id of the consumer
- providerId - the unique id of the provider

WS-Agreement:
The EJSDLMarket document is the first result of the (technical and economic) match of a consumer bid and provider offer. A WS-Agreement document is the second result of a match and represents the final Service Level Agreement (SLA) between both parties (see Example 4) and is composed of three main elements:

- Context – the identification of who is participating in the SLA and their roles (i.e. consumer or provider), the validity period of the SLA can also be defined here.
- Service Terms – what is being provided and how it is accessed
- Guarantee Terms – the promises made by both parties. These are observable properties and are used to identify the outcome of the agreement. Here, the economic properties associated to the terms are also quantified. For example, the penalty if the promise is broken.

The EJSDLMarket document is returned to the participants of a match (and therefore also of the SLA) contains the contract id of the generated WS-Agreement document, which enables each participant to access the SLA, maintained by Contract Management (see D2.2), if they wish.

SORMA Message Examples:
Examples of SORMA messages are reported in the Appendix of this document

SORMA Market Administrators Manuals

4.5. Introduction

The SORMA market is composed by a set of server-side components. Some of these components offer their own user interface (GUI) that allows SORMA System Administrators to maintain the system and to monitor what is happening in the SORMA system.

All components can be found on the SORMA system DVD, as described in section 1.1.1 of this document

4.6. Installation and Configuration Guide

This section of the user guide describes how administrators can install, configure and test SORMA.

The components to be installed are:
1. Market Exchange Service
2. Market Information Service
3. Payment Service
4. Trading Management
5. Contract Management and Billing
6. SORMA Global Logging

The security infrastructure is a horizontal feature and it is explained in the next paragraph (5.3)

4.6.1. Market Exchange Service

a. Pre-requisites

- Linux based platform (i.e. Ubuntu)
- Sun Java Development Kit 1.6
- Apache ant 1.6 and up to use the component launching scripts.

b. Core Market Services Port Requirements

Components that make up the core market services require a number of network ports to be open. Defaults are given in the following table:

Component	Port number (ServerSocket)	Where this component is conceptually located? (Consumer-side, Provider-side, Trusted Market machines, Portal?)	Port description
gmm: exchange service	typically 8090, but any can be used	Trusted Market Exchange	Port used by clients to invoke exchange service using web services to submit bids

c. Installation and Configuration

The SORMA Market Exchange forms the backbone of SORMA. The Market Exchange can be installed by following the instructions in this section.

The Market Exchange can be installed by downloading the binaries from the SORMA DVD:

```
/ivy/sorma/eu.sormaproject/market-exchange/LATEST/market-
exchange.tar.gz
```

To install, decompress the binaries:

```
tar -xvzf market-exchange.tar.gz
```

You should get the directory market-exchange-<version> created in the current directory. Its structure should be:

- lib: a directory with the exchange service code (in the market-exchange-<version>.jar file) and its dependencies
- samples: a directory with the sample applications
- gmm.properties: basic configuration for the GMM
- exchange.properties: default configuration for the exchange service. Must be adapted to the current execution environment
- log4j.properties: configuration of message logging
- launch.xml: ant file to launch the exchange

d. Configuration Steps

The Exchange Service can be configured using a properties file. The properties that can be configured are listed on the following page.

Property	Default value	Description	Comments
hosting.config. service.exchange	$service.exchange$	Includes the exchange service as a service in the gmm middleware	Don't change
service.exchange.name	ExchangeService	Name of the Exchange Service	Don't change
service.exchange.builder	edu.upc.cnds.gmm.p2pagent. configuration.builders. ServiceBuilder	Define the factory for this service.	Don't change.
service.exchange.class	edu.upc.cnds.gmm.coreservices. exchange.impl. MarketExchangeService		Don't change unless you are providing an alternative implementation of the service
service.exchange. param.channel	HttpChannel	Specifies the communication transport to be used by the exchange service	Can be changed to any of the transports installed in the gmm (e.g. PastryChannel)
service.exchange. config.agent	$agent.exchange$	Adds the Exchange Service's agent to the gmm middleware	Don't change.
agent.exchange.name	ExchangeServiceAgent	Name of exchange service's agent	Informative value. Can be changed to any name.
agent.exchange.builder	edu.upc.cnds.gmm.p2pagent. configuration.builders. AgentBuilder	Factory class used to create the agent.	Don't change
agent.exchange.class	eu.sormaproject.gmm.coreservices. exchange.cspace.imp. ExchangeServiceAgent	Class that implements the exchange service's agent	Can be changed to use an alternative implementation of the service.
agent.exchange.param.channel	HttpChannel	Specifies the communication transport to be used by clients to contact the exchange service	Can be changed to any of the transports installed in the gmm (e.g. PastryChannel)
agent.exchange.param.cspaceHost	N/A	host name used to contact the CSpace	Change to adapt to your actual deployment of SORMA components
agent.exchange. param.cspacePort	8095	Port used by the CSpace's web services container	Change to adapt to your actual deployment of SORMA components
agent.exchange. param.cspaceService	/cspace/services/ ProtocolExecutorAdapterService	Name of the CSpace services as deployed in the web services container	Change to adapt your actual deployment of the SORMA components
agent.exchange. param.conversation	N/A	Name of a conversation to be automatically registered at start up	Must match the name of an existing conversation in CSpace

The default name of this file is *exchange.properties* and is expected to be in the exchange's working directory (the directory it was launched from). This can be changes passing the following command line arguments when launching exchange:

```
ant exchange -Dapp.args="-config.file <config file path>"
```

Any property can be overridden, and new properties can be added, passing them in the command line.

```
ant exchange -Dapp.args="-<property> <value>"
```

e. Verify the installation

This test application has three components:

- The ExchangeService, which runs the exchange service.
- The Auctioneer, which runs a continuous double sided auction.
- Two clients, a seller and a buyer which ask/offer on the auction.

To start the application, follow the next steps:

1. Be sure that the gmm libraries are in the lib directory
2. Be sure that the following files are in your current directory:
    - gmm.properties: basic configuration of the gmm
    - Exchange.properties: configuration to launch the exchange service
    - client.properties: configuration for clients (including the protocol executor)
3. Launch the Exchange Service with the command

```
ant -f launch.xml exchange
```

You should see the message in the console

```
Initializing Exchange Service Agent
```

4. Launch the protocol executor with the command:

```
ant -f launch.xml auctioneer -Dapp.args="<url> <port> <auction>"
```

where:

- <url> is the url to contact the exchange service
- <port> is the local port used to listen to messages from the exchange
- <auction> is the name of the auction

You should see the following message in the exchange console

```
Creating session: <auction>
```

where, <auction> is the auction name as passed to the auctioneer.

Example:

```
ant -f launch.xml auctioneer -Dapp.args="http://localhost:8090 8099 theAuction"
```

5. Launch the clients (Seller/Buyer) are launched with the command:

```
ant -f launch.xml client -Dapp.args="<file>  <url>"
```

where:

- <file>: name of the xml file used to describe the terms of the proposal
- <url>: url to access the exchange service

You should see the following message in the exchange server console

```
Message: Handling negotiation from <user>
```

where <user> is the user passed to the client.

Once two clients with matching bids are started, the following message should appear in the console of each client.

Response received

Example:

```
ant -f launch.xml client -Dapp.args="ask.xml http://localhost:8090"

ant -f launch.xml client -Dapp.args="offer.xml http://localhost:8090"
```

4.6.2. **Market Information Service**

a. Pre-requisites

- Java 1.6
- Apache ant 1.6 and up to use the component launching scripts.

b. Download

The configuration files and the library, which are necessary for the testing of the market information service can be downloaded from the SORMA DVD:

```
/ivy/sorma/eu.sormaproject/marketInformation/LATEST/marketInformatio
n-config.tar.gz
```

The Market Information Service package is available on the SORMA DVD:

```
/ivy/sorma/eu.sormaproject/marketInformation/LATEST/marketInformatio
n.jar
```

c. Testing

Go to the folder with downloaded marketInformation.jar and run the following command:

```
java -jar marketInformation.jar mis.properties
```

where *mis.properties* is the direction to the properties file.

Alternatively you can type the following command line:

```
java -cp .:marketInformation.jar:lib/ eu.sormaproject.coreMarketServices.marketInformation.Test
mis.properties
```

where *mis.properties* is the direction to the properties file.

d. Configuration

The following table describes the configuration parameters for the MIS (see *mis.properties* file within the configuration package of the download section), depending if the MIS is using a database or an overlay. Using the database allows to connect via HTTP to firewall protected machines and allows and easier setup of the system.

Property	Default value	Description	Comments
overlay		Configuration parameters when using an overlay as communication protocol	
overlay.port	20000	Includes the exchange service as a service in the gmm middleware	the port must be open (not behind a firewall or NAT)
overlay.bootport	20000	Includes the exchange service as a service in the gmm middleware	the port must be open (not behind a firewall or NAT)
overlay.IP	147.83.34.222	Includes the exchange service as a service in the gmm middleware	Please consider that "localhost" does *not* work
overlay.type	ScribeSimulator	Defines the type of the used overlay	possible types are 'Kad', 'Scribe' and 'ScribeSimulator'
db		Database configuration parameters	
mis.db.subscription.delay	1000	Defines the reloading of the subscription service for new update	
db.table	MIS_Table	name of the table	
db.jdbcDriver	org.hsqldb.jdbcDriver	Defines the sql connection driver	
db.connection	jdbc:hsqldb:http://pcmargenat.ac.upc.edu:8880/	defines the connection direction	It uses a http connection as default to pass firewalls
db.filenames	misdb	Name of the database file	
db.username	sa	username for the connection	
db.createTable	false	Defines if a table is created	Attention: existing tables will be overwritten
test		Configuration parameters to test and evaluate the MIS	
test.max_instances	10	defines the number of created MIS instances (nodes)	
test.node	8	defines the instance (node), which executes the testing actions like a query	
test.query	true	Defines if the test node executes a query to all nodes	
test.publish	false	Defines if the test node does a publishing	
log		Defines properties for the logging	
log.file	log4j.properties	Defines the path to the file with the logging properties	

4.6.3. **Payment Service**

a. Prerequisites
The following software must be installed in order to setup and use the Payment Component:

1. Java 1.6.0
2. Web Server Java based (Tomcat , JBoss, Apache, etc…)
3. Axis 1.2 (integrated in web server)

b. Installation
To install the Payment Component you first have to get the file from the SORMA DVD:

```
/ivy/sorma/eu.sormaproject/paymentComponent/LATEST/payment.war
```

Copy the war archive in the proper folder of the Web Server

c. Usage
The Payment Component has been implemented as a web service, so in order to use the component it is necessary to build a client and invoke the needed methods. Since the client can be built in several ways this point will be skipped in this manual. Instead the following section will explain the methods and how to invoke them.

String makeSubscription() This method returns the URL of the chosen payment tool (in string format). It is used to redirect the user to the page of the payment tool to fulfil those operations that must be performed using the tool's proprietary web pages.

String executePayment(String strXmLPayment) This method takes in input a string in XML format and performs an automatic payment to the selected payment tool.
The input string has such format:

```
<pay:PaymentDetails xmlns:pay="http://www.sormaproject.eu/message/sla/payment">
   <pay:AgreementId>job123-Provider123</pay:AgreementId>
   <pay:Consumer>UKA</pay:Consumer>
   <pay:Provider>CU</pay:Provider>
   <pay:Price>10.0</pay:Price>
   <pay:CreditCardType>Visa</pay:CreditCardType>
   <pay:CreditCardNumber>4059042064101342</pay:CreditCardNumber>
   <pay:ExpiryDate>102010</pay:ExpiryDate>
   <pay:CVV2>962</pay:CVV2>
</pay:PaymentDetails>
```

The output string varies depending if the operation is successful or not. If the operation is successful, then this XML string is returned:

```
<pay:PaymentResponse xmlns:pay="http://www.sormaproject.eu/message/sla/payment">
   <pay:Outcome xsi:type="pay:SuccessfulOutcome_Type"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
   <pay:Timestamp>2009-01-14T02:57:19.185-08:00</pay:Timestamp>
   <pay:TransactionId>4PV764397R589480U</pay:TransactionId>
   </pay:Outcome>
</pay:PaymentResponse>
```

If there are some errors, then the following XML string is returned:

```
<pay:PaymentResponse xmlns:pay="http://www.sormaproject.eu/message/sla/payment">
   <pay:Outcome xsi:type="pay:ErrorOutcome_Type"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
   <pay:Timestamp>2009-01-14T02:49:15.857-08:00</pay:Timestamp>
   <pay:ErrorCode>ERROR_ID</pay:ErrorCode>
   <pay:Description>Internal Error</pay:Description>
   </pay:Outcome>
</pay:PaymentResponse>
```

Note that the SORMA Message API providers parsers for this document format.

4.6.4. Trading Management

The SORMA Trading Management (TM) is a web application designed to run within a Tomcat server. The TM uses a MySQL database to hold data associated with the protocols it is able to execute (the so called common storage). Additionally, Trading Management communicates with the SORMA Market Exchange and the SORMA Market Information System.

To install the SORMA Trading Management is necessary to follow these steps:

1. Configure a MySQL user allowed to create and modify the Trading Management database. (Do NOT create the database manually)
2. Deploy the C-Space Protocol Executor web application.
3. Configure the Protocol Executor.
4. Upload a JAR file containing the CDA protocol to the Protocol Executor.
5. Create a CDA conversation.

a. Prerequisites

No other SORMA components need to be installed prior to the installation and deployment of the Trading Management component. The following SORMA components must, however, be installed prior to the execution of the Trading Management:

- SORMA Market Exchange
- SORMA Market Information

The following third party software must be installed before installing the Trading Management:

- Sun Java 1.6
- MySQL 5
- Apache Tomcat 5.5
- MySQL can be installed on a remote machine.

b. The Installation Process

Dowload the following files from the DVD:

- `/ivy/sorma/eu.sormaproject/cspace/LATEST/cspace.war`
- `/ivy/sorma/eu.sormaproject/cspace/LATEST/cspace.properties`
- `/ivy/sorma/eu.sormaproject/cspace/LATEST/cda-protocol.jar`

1) Configure MySQL
Login to MySQL:

```
mysql -u root -p
```

To configure a MySQL user for the Trading Management, execute the following line using a mysql client:

grant select, insert, update, delete, create on cSpaceDB.* to \
"<mysql-user>"@<cspace-host> identified by '<mysql-password>';
Here, <cspace-host> is the host where the Trading Management is being installed. <mysql-user> and <mysql-password> should be consistent with the corresponding entries in the cspace.properties file (see below).

2) Deploy the C-Space Protocol Executor Web Application
Start your Tomcat server:

$CATALINA_HOME/bin/catalina.sh start
Copy the *cspace.war* to your Tomcat's webapps directory

This should automatically deploy the service.

3) Configure the Protocol Executor
Download the properties template file and open it in a text editor. You should see something like this:

```
############################
#   C-Space Properties   #
############################

################################
# Public address of Protocol Executor
################################
cspace.public.protocol=http
cspace.public.host=193.10.67.191
cspace.public.port=8080


################################
# Database connection properties
################################
cspace.mysql.host=localhost
cspace.mysql.username=cspace_executor
cspace.mysql.password=mammamia
cspace.mysql.port=3306


#################################
# Information Service
#################################
cspace.informationService.namespace=cspace.informationService.sorma

# MIS Information Service
cspace.informationService.sorma.factory.className=eu.sormaproject.cspace.mis.MISInformationServiceFactory
cspace.informationService.sorma.host=pcmargenat.ac.upc.edu
cspace.informationService.sorma.port=8880

# Test Information Service
cspace.informationService.test.factory.className=eu.sormaproject.cspace.information.NullInformationService
```

```
##################################
# Message Layer
##################################


# Exchange Message Layer
        #Note: cspace.messageLayer.sorma.exchange.client.port
        #is the first port the client will try to open for
        #incoming connections (from the service host).
        #If it fails to open this one it will increment the
        #port number by 1 and try again, etc.
cspace.messageLayer.sorma.factory.className=eu.sormaproject.cspace.exchange.ExchangeMessageLayer$Factory
cspace.messageLayer.sorma.exchange.service.host=147.83.30.215
cspace.messageLayer.sorma.exchange.service.port=14080
cspace.messageLayer.sorma.exchange.client.port=8090
# Test Message Layer
cspace.messageLayer.test.factory.className=eu.sormaproject.cspace.message.TestMessageLayer$Factory
cspace.messageLayer.test.port=8888
```

Edit the values to suit your setup. The properties with prefix "cspace.public" are used to determine how external clients should connect to the C-Space service.

Properties with prefix "cspace.mysql" are used to setup a connection to the database you configured previously.

Make sure the two following properties are set as follows:

```
cspace.messageLayer.namespace=cspace.messageLayer.sorma
cspace.informationService.namespace=cspace.informationService.sorma
```

This will tell C-Space to use the properties with prefix "cspace.messageLayer.sorma" for setting up the messaging layer, and properties with prefix "cspace.informationService.sorma" for the information service. Therefore, regarding the message layer and the information service, it is only necessary to provide values for properties with these prefixes.

Now, point your web browser to the C-Space Manager web page at http://localhost:8080/cspace. NOTE! You should change the port number to your own tomcat's HTTP port.

You will see a page like the screen shot shown in Figure 43.

Click "Browse" in the section named "Configure C-Space Protocol Executor", select the properties file you just modified, and click "Configure".

You should now see a message saying that the Protocol Executor has been configured.

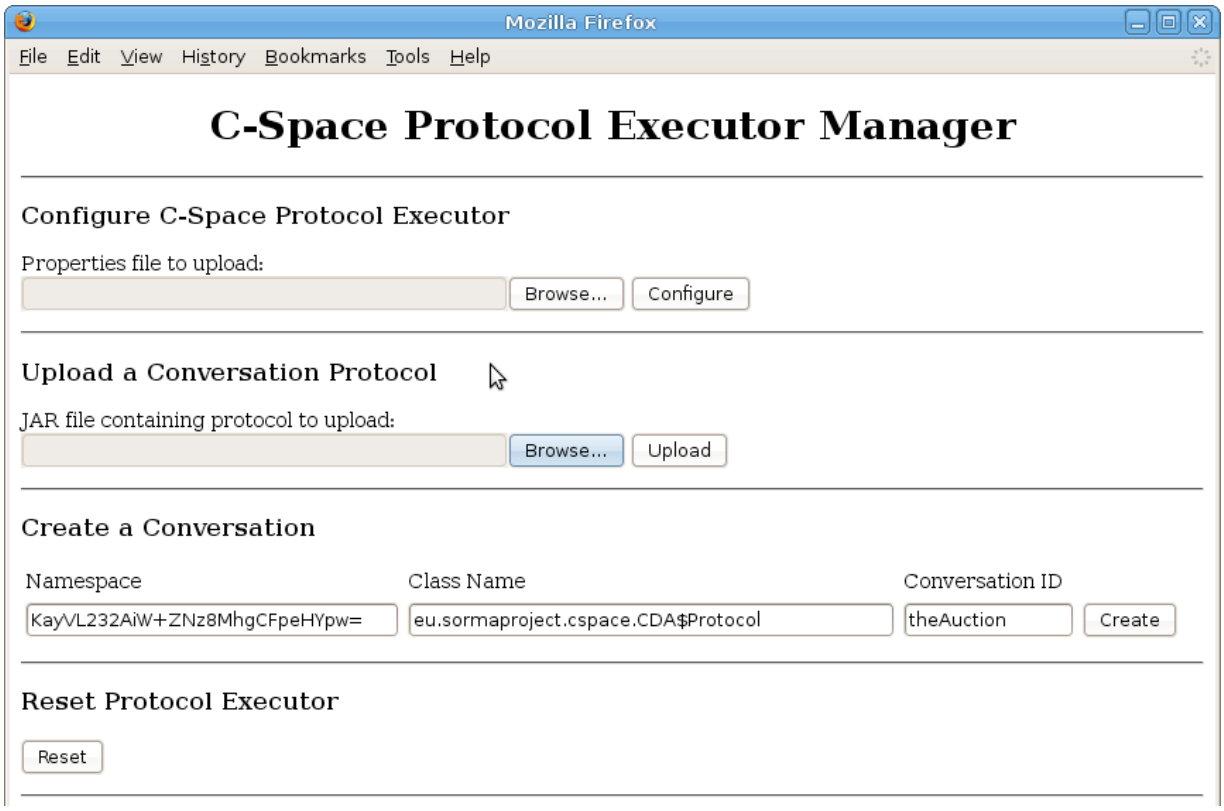


Figure 43: C-Space Protocol Execution Manager

4) Upload the CDA Conversation Protocol
Download the CDA protocol JAR file.

Again, point your web browser to C-Space Manager web page. Click "Browse" in the "Upload a Conversation Protocol" section, and select the JAR file you just downloaded. Finally, click the "Upload" button.

You should now see a message confirming that the upload succeeded, and displaying the "namespace" of the uploaded jar file. Remember (or copy) the namespace string, as you will need it in order to create a new conversation in the next step.

5) Create the CDA Auction
On the C-Space Manager web page, in the section named "Create a Conversation", modify the "Namespace" entry, if the default value is different from the namespace you received when uploading the CDA protocol jar. The other values should be left as they are. Click "Create".

Now the SORMA Trading Management should be successfully setup. You can reset it by clicking the "Reset" button on the C-Space Manager web page

4.6.5. **Contract Management and Billing**

The Contract Management component is responsible for the generation, runtime logic and enforcement of Service Level Agreements (SLAs). This entails the support of other SORMA components in respect to SLA-related issues, and the guidance of an SLA through its lifecycle. It is implemented as a library with a web service front end. This document describes how it can be deployed as a web service.

This component is a downstream component of:

- SORMA Trading Management Component
- SORMA Intelligent Tools

and an upstream component of:

- SORMA Payment Component
- SORMA Market Information
- SORMA EERM

There are two tasks involved in the installation of the web service and there is no particular order in which they need to be carried out.

- Runtime Configuration
- Service Deployment

a. Prerequisites

No other SORMA components need to be installed prior to the installation and deployment of the Contract Management component. The following SORMA components must, however, be installed prior to the invocation of this component:

- SORMA Payment Component
- SORMA Market Information
- One or more SORMA EERM instances

The following third party software must be installed before installing the Contract Management Web Service:

- Sun Java 1.6
- Apache Tomcat 5.5 with a JAX-WS installation

b. Service Deployment

To deploy the web service, obtain ContractManagement.war from the SORMA DVD:

```
/ivy/sorma/eu.sormaproject/ContractManagement/LATEST/ContractManagement.war
```

Place the war file in the webapps directory of the Tomcat server. Tomcat will now explode the war and install the service.

c. Runtime Configuration

The war file on the SORMA DVD comes with a pre-packaged configuration file, it is not expected that the configuration will remain consistent over time, and therefore this must be modified. To do this a new version of the properties file must be supplied. It is very important that the properties file is placed in the correct location otherwise ContractMangement will be unable to find it and therefore function incorrectly.

The properties file should be placed in the current directory (where the Tomcat server was started), or a relevant subdirectory anywhere in this directory tree; ContractMangement will search for the properties file, if it cannot (initially) find it. However, in order to save unnecessary disk traversal during the search process ContractMangement will search only subdirectories of the current directory, and will go up the directory tree **only once** to search other sibling directories of the current directory. The name of the properties file is also important it must be called *SLARuntime.properties* and follow the structure as outlined below.

There are in principal two sections of the SLARuntime.properties file. Firstly, those which are not expected to change in the short term, and secondly, those which are installation specific.

The *fixed* properties are presented below and define the implementation of ContractManagement. In the event that the functionality of the component is to be changed it is the values specified here that will enable future developers to modify the internal implementation of the component.

```
#Implementation of the SLARegistry to use
SLARegistry=eu.sormaproject.sla.registry.impl.SLARegistryHD
#The Servicename of the EERM's JobManagement Service
EERM.JobManager.Servicename=WSJobManagerService
#The Servicename of the EERM's SLAEnforcement Service
EERM.SLAEnforcement.Servicename=WSSLAEnforcementService
#The Servicename of the EERM's EconomyManager Service
EERM.EconomyManager.Servicename=WSEconomyManagerService
#The namespace URI for the EERM
EERM.namespaceURI=http://ws.sormaproject.eu/eerm
#ContractManagement Interface to use
ContractManagement=eu.sormaproject.sla.impl.ContractManagementImpl
#SLAEnforcement Interface to use
SLAEnforcement=eu.sormaproject.sla.enforcement.impl.SLAEnforcementImpl
```

The implementation specific properties are presented below and define the settings which are context specific. **Note**: that it is necessary to know where the payment component is prior to the first invocation of the ContractManagement component.

```
#Location of the Payment Component
Payment.location==http://147.83.30.246:12080/SORMA_Payment/services/Payment
#Location of the SLA Files for different operating systems, this is important as
it defines where the component will output all documents related to the SLA
lifecycle
SLARegistryHD.location.Linux==/home/scmsjc/
SLARegistryHD.location.Windows\ XP==D:\\
```

4.6.6. **SORMA Global Logging**

a. Prerequisites

- log4j
- (Optional) Chainsaw v2 - GUI for displaying the log4j messages, which is running like a log-server and listening to a specified port

b. Installation Steps

- Download and unpackage the LoggingService from the SORMA DVD: `/ivy/sorma/eu.sormaproject/loggingService/LATEST/loggingService.tar.gz`
- Configure the logserver-properties (see section Configuration)
- Start the LogServer:

```
java -cp loggingService.jar:lib/* eu.sormaproject.logging.service.LogServer <PORT-
NUMBER> logserver.properties
```

Example call:

```
java -cp loggingService.jar:lib/* eu.sormaproject.logging.service.LogServer 16999
logserver.properties
```

c. Configuration

The **sorma-common** java package contains two additional logging levels, based and extending the log4j *Level*-interface, SORMALevel and DEMOLevel. The SORMALevel can be used from the components to submit important messages of the running SORMA System in order to document the various processes, whereas SORMADemo can be used, when SORMA is used in DEMO mode.

server.properties:

Following properties describes the configuration of the SORMALevel and DEMOLevel in the server.properties file.

```
log4j.rootCategory=INFO, Default, DEMO
#
# The default file appender
#
log4j.appender.Default=org.apache.log4j.RollingFileAppender
log4j.appender.Default.Threshold=SORMA#eu.sormaproject.logging.level.SORMALevel
log4j.appender.Default.File=SORMALevel.log
log4j.appender.Default.layout=org.apache.log4j.PatternLayout
log4j.appender.Default.layout.ConversionPattern=%d (${dbUserid}) %c{1} [%p] %x -
%m%n
# Do not Truncate if it already exists.
log4j.appender.Default.Append=true
log4j.appender.Default.MaxFileSize=1500KB
# Archive log files (one backup file here)
log4j.appender.Default.MaxBackupIndex=10

#
# The DEMO file appender
#
log4j.appender.Default=org.apache.log4j.RollingFileAppender
log4j.appender.Default.Threshold=DEMO#eu.sormaproject.logging.level.DEMOLevel
log4j.appender.Default.File=DEMOLevel.log
log4j.appender.Default.layout=org.apache.log4j.PatternLayout
log4j.appender.Default.layout.ConversionPattern=%d (${dbUserid}) %c{1} [%p] %x -
%m%n
# Do not Truncate if it already exists.
log4j.appender.Default.Append=true
log4j.appender.Default.MaxFileSize=1500KB
# Archive log files (one backup file here)
log4j.appender.Default.MaxBackupIndex=10
```

log4j.properties:

```
log4j.rootCategory=INFO, Default, SORMA

...

# The Socket Appender

log4j.appender.SORMA=org.apache.log4j.net.SocketAppender
log4j.appender.SORMA.Threshold=DEMO#eu.sormaproject.logging.level.SORMALevel
log4j.appender.SORMA.RemoteHost=147.83.30.215
log4j.appender.SORMA.Port=16999
log4j.appender.SORMA.ReconnectionDelay=5000
log4j.appender.SORMA.LocationInfo=true
```

d. Example
Following code snipped is an example for submitting of a log-message to the configured logging-server. If the log4j.properties are not already bound, they have to initialized. The "special" logs have to be submitted using the **DEMO** logging level.

```
PropertyConfigurator.configure(some_path+"log4j.properties");

logger.log(DEMOLevel.DEMO, "Client submits a bid-request to AgentService");
// ...
logger.log(DEMOLevel.DEMO, "AgentService uses the BiddingFramework to generate a
bid and submit it to Market Exchange");
// ...
logger.log(DEMOLevel.DEMO, "Market Exchange receives the bid and addresses the bid
message to the auction \"theAuction\" ");
// ...
logger.log(DEMOLevel.DEMO, "Trading Management receives the bid and tries to match
it with a stored offer");
```

4.7. How to Apply Security Infrastructure

The Security component is implemented as a set of services built on top of the Dorian security framework. The security services are implemented as WSRF services using Globus WS-Core framework. This guide describes the procedures for deploying the security services in an Apache Tomcat web container. The operating system is assumed to be Linux.

4.7.1. **Prerequisites**

1. Java JDK 1.5.0_17 or later version
2. Ant 1.6.5
3. MySQL 5.0
4. Apache Tomcat 5.5.X

4.7.2. **Deploying the Services**

Before deploying the services, we need to copy several Jar files from the Globus WS-core framework to some of the Tomcat directories. From here on in this guide, we refer CATALINA_HOME as the directory where Apache Tomcat is installed.

1. Download the required Jar files from the SORMA DVD: `/ivy/sorma/eu.sormaproject/security/LATEST/sorma-security-tomcat-lib.zip`
2. Unzip the file to a temp directory.
3. Copy "cog-tomcat.jar" to "CATALINA_HOME/server/lib".
4. Copy "xalan.jar" to "CATALINA_HOME/common/endorsed".
5. Copy the following files to "CATALINA_HOME/common/lib":
    1. cog-jglobus.jar
    2. xml-apis.jar
    3. cryptix.jar
    4. cryptix-asn1.jar

5. cryptix32.jar
6. jce-jdk13-125.jar
7. jgss.jar
8. log4j-1.2.8.jar
9. puretls.jar

a. Deploy the WAR

The security services are packaged as a generic WAR file, which can be deployed in any web application server. In this guide, Apache Tomcat 5.5.26 is used. Before going through the installation, make sure that Tomcat is installed and running properly.

1. Download the WAR file from the SORMA DVD: `/ivy/sorma/eu.sormaproject/security/LATEST/sorma-security.war`
2. Copy the WAR file "sorma-security.war" to the Tomcat webapps directory. This should automatically deploy the service in the "sorma-security" directory.

b. Configure the Service

The services are configured through a single configuration file which is located at:

```
 CATALINA_HOME/webapps/sorma-security/WEB-
INF/etc/SORMASecurityService_Dorian/dorian-conf.xml
```

For simple deployments only the following configuration elements need to be modified.

1. Database Configuration
2. CA Subject Name

c. Database Configurations

To modify the database configuration to interact with MySQL database please set the values of the host, port, username, and password elements (highlighted in bold below).

```
 <?xml version="1.0" encoding="UTF-8"?>
 <DorianConfiguration xmlns="http://cagrid.nci.nih.gov/dorian/conf"
   ....
   <DatabaseConfiguration>
       <host>localhost</host>
       <port>3306</port>
       <username>root</username>
       <password></password>
   </DatabaseConfiguration>
   ....
   <AutoCreate>
       <CASubject>C=EU,O=SORMA,OU=Security,CN=SORMA CA</CASubject>
       <CAKeySize>2048</CAKeySize>
       <lifetime years="25" months="0" days="0" hours="0" minutes="0"
seconds="0"/>
   </AutoCreate>
 ....
```

d. Certificate Authority Subject Name

It is important that the subject of the CA certificate is unique and meaningful to your deployment. To set the subject of the certificate authority for your deployment, edit the CASubject element. The default value of "C=EU,O=SORMA,OU=Security,CN=SORMA CA" is provided as an example.

4.7.3. Configure to Trust the CA

The Security component includes a CA that will be acting as the SORMA CA. In order to use the security services with this CA, you need to configure for the services to trust the CA. To do this, a utility script is provided. Note that you should run the script as the user that starts up the Tomcat service, so that the CA certificate will be place in the correct directory.

1. Change to CATALINA_HOME/webapps/sorma-security/bin directory.

2. Run "trustcert".

```
 # ./trustcert
 Succesfully configured Globus to trust the Dorian CA:
C=EU,O=SORMA,OU=Security,CN=SORMA CA
 Succesfully wrote CA certificate to /root/.globus/certificates/d2e41d5e.0
 Succesfully wrote CA signing policy to
/root/.globus/certificates/d2e41d5e.signing_policy
```

Note: When this script is run, the command also creates the necessary database tables in MySQL.

4.7.4. Get Host Credential

In order to run the security services, the host that the services are deployed on need to generate host certificate and private key. To obtain the certificate and key, a utility script is provided. Note that you should run the script as the user that starts up the Tomcat service, so that the certificate and key files will be owned by that user.

1. Change to CATALINA_HOME/webapps/sorma-security/bin directory.

2. Run the "gethostcred" script and enter the appropriate values.

```
 # ./gethostcred
 Enter the hostname:myhost
 Enter the directory to write the host certificate and private key to:.
 /C=EU/O=SORMA/OU=Security/OU=SORMA IdP/CN=dorian
 Successfully created the host certificate:
 Subject: C=EU,O=SORMA,OU=Security,OU=Services,CN=host/myhost
 Created: Thu Jan 29 16:29:09 SGT 2009
 Expires: Wed Jan 29 16:29:09 SGT 2014
 Succesfully wrote private key to /opt/apache-tomcat-5.5.27/webapps/sorma-
security/bin/./myhost-key.pem
 Succesfully wrote certificate to /opt/apache-tomcat-5.5.27/webapps/sorma-
security/bin/./myhost-cert.pem
```

3. The credential files are generated in the current directory. Move the certificate and key PEM files to a secure location.

```
# mv *.pem /root/.globus/certificates
```

4. Verify permissions.

```
# ls -l
total 16
-rw-r--r-- 1 root root 1249 2009-01-29 16:49 d2e41d5e.0
-rw-r--r-- 1 root root  111 2009-01-29 16:49 d2e41d5e.signing_policy
-rw-r--r-- 1 root root 1090 2009-01-29 14:17 myhost-cert.pem
-rw------- 1 root root  891 2009-01-29 14:17 myhost-key.pem
```

4.7.5. **Configure HTTPS for Tomcat**

Communication with the security services has to be over a secured channel, therefore it is mandatory to use HTTPS. This section describes how to configure HTTPS with Tomcat 5.5.X.

1. Use a text editor (e.g. vi) and open the Tomcat configuration file at "CATALINA_HOME/conf/server.xml".

2. Add a HTTPS Connector in the <Service name="Catalina"> section as below and update the parameters (highlighted in bold) appropriately with your local configuration:

```
....
<Service name="Catalina">
....
<Connector className="org.globus.tomcat.coyote.net.HTTPSConnector"
    port="8443" maxThreads="150" minSpareThreads="25" maxSpareThreads="75"
autoFlush="true"
    disableUploadTimeout="true" scheme="https"
    enableLookups="true" acceptCount="10" debug="0"
    protocolHandlerClassName="org.apache.coyote.http11.Http11Protocol"
    socketFactory="org.globus.tomcat.catalina.net.BaseHTTPSServerSocketFactory"
    cert="/root/.globus/certificates/myhost-cert.pem"
    key="/root/.globus/certificates/myhost-key.pem"
....
```

NOTE: The cert and key files are the host cert and key that were obtained in the previous section.

3. Add a HTTPS Valve in the <Engine name="Catalina" ... > section:

```
<Engine name="Catalina" defaultHost="localhost">
....
    <Valve className="org.globus.tomcat.coyote.valves.HTTPSValve55"/>
....
```

4. In the HTTPS Connector (step 2 above), the default port used is 8443. If there is a need to use other port number (i.e. 443), you also need to modify the Security component's web.xml file located at:

```
CATALINA_HOME/webapps/sorma-security/WEB-INF/web.xml
```

Change the defaultPort value (highlighted in bold) to the number you used in the HTTPS Connector configuration.

```
<web-app>
....
  <servlet>
      <servlet-name>WSRFServlet</servlet-name>
      <display-name>WSRF Container Servlet</display-name>
      <servlet-class>
          org.globus.wsrf.container.AxisServlet
      </servlet-class>
      <init-param>
          <param-name>defaultProtocol</param-name>
          <param-value>https</param-value>
      </init-param>
      <init-param>
          <param-name>defaultPort</param-name>
          <param-value>443</param-value>
      </init-param>
      <load-on-startup>true</load-on-startup>
  </servlet>
....
</web-app>
```

Now the security services should be running. To verify, start a browser window and point it to "https://localhost:8443/sorma-security/services" (change hostname and port as appropriate) and you should see a list of services. Scroll through list and look for the SecurityManager service (see the following screenshot):

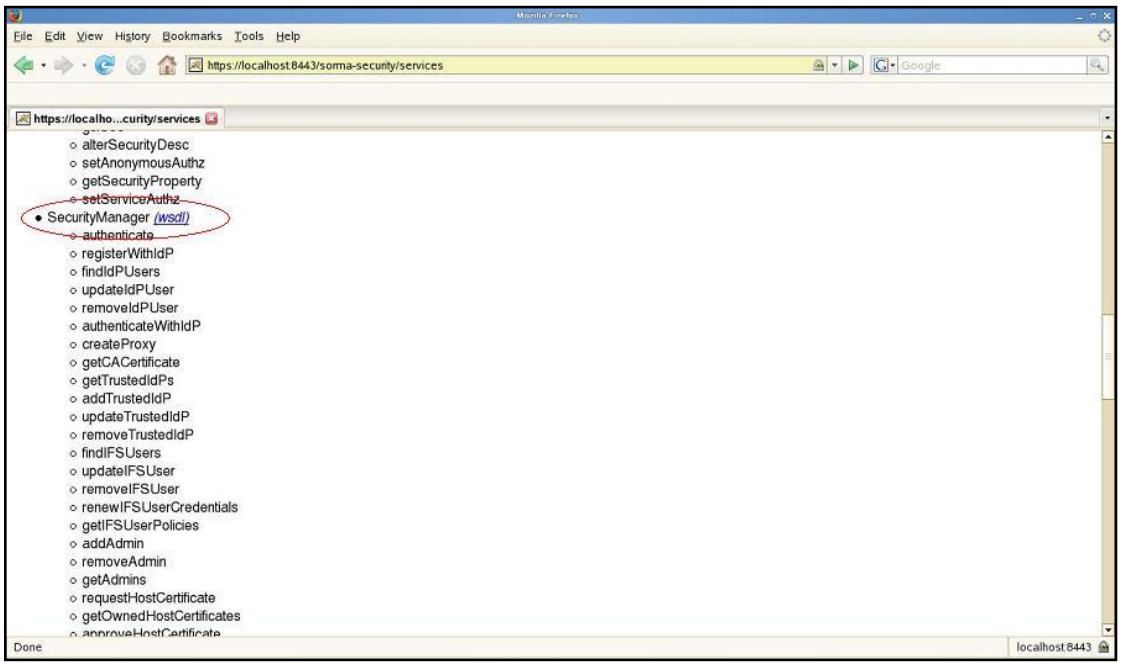


Figure 44: Security screenshot

4.7.6. **Testing the Security services with a Sample Client**

1. Download the binaries of the sample client from the SORMA DVD:
`/ivy/sorma/eu.sormaproject/security/LATEST/examples.zip`

2. Unzip the archive and cd into the directory.

```
$ unzip examples.zip
$ cd examples
```

3. Set up the Java classpath by sourcing the setenv.sh file in the etc directory.

```
$ . etc/setenv.sh
```

4. Test that your classpath is correct by running the sample client.

```
$ java eu.sormaproject.security.examples.LoginClient
Please specify the service URL!
```

5. Create a "certs" directory in the examples directory.

```
$ mkdir certs
```

6. Obtain the public certificate of the CA used by the Security service. The CA certificate is obtained in step 2 of section "Configure to Trust the CA" of this guide (filename is d2e41d5e.0). This certificate is required to configure the security APIs to trust the CA. Copy this file that contains the certificate to the certs directory.

```
$ cp d2e41d5e.0 certs
```

7. Finally run the sample client again with the service URL.

```
$ java eu.sormaproject.security.examples.LoginClient
https://<serviceurl>:<port>/sorma-security/services/SecurityManager
```

4.7.7. **Deployment of User Registration Web Form**

The registration form is written in PHP and can be deployed in any PHP application server. To deploy the web form:

1. First download the file "registration.php" from the Sorma DVD: `/src/sorma/trunk/openGridMarket/securityManagement/userAccountRegistration/ registration.php`
2. Open the PHP file with a text editor and look for "<CHANGE_ME@SORMA.COM>" as below:

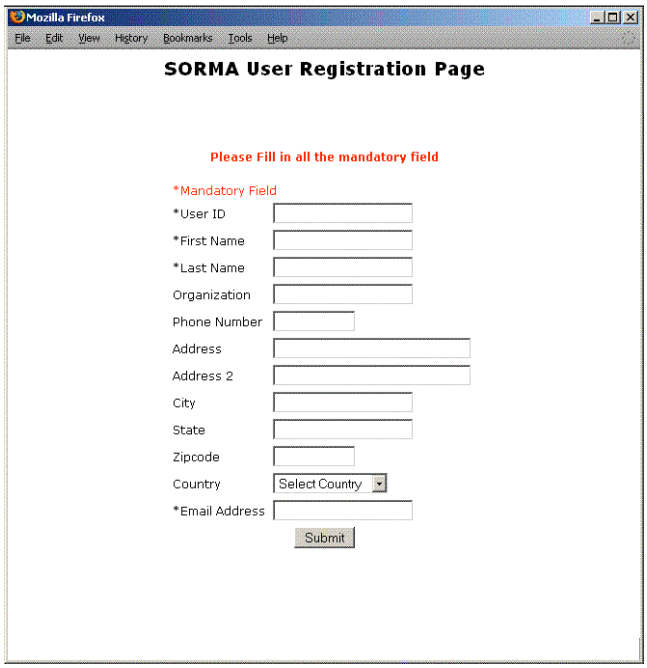
```
...
<?php
$admin_email="<CHANGE_ME@SORMA.COM>";
$success=0;
...
```

3. Modify and add a proper email address that belongs to a designated SORMA administrator. This email address will receive the registration request when someone submits an application.

```
...
<?php
```

```
$admin_email="register@sorma.com";
$success=0;
...
```

4. Copy the PHP file to the web directory of a PHP application server. For example, for an Apache web server, copy the file to "httpd/htdocs/sorma" directory.
5. Start up the Apache web server and point the browser to "http://your_host:port/sorma/registration.php". The registration page will be displayed as follows.



4.8. SORMA Administrator User Guide

The SORMA System can support the Administrator in the following tasks thanks to a set of GUI offered by the following components:

- Monitoring / logging GUI
- SLA Administrator GUI
- Security Administrator GUI

4.8.1. SORMA Logging GUI

SORMA-Global-Logging provides a functionality to submit (redirect "special") log messages from different and distributed SORMA components to a central logging instance (log-server).
Chainsaw is a GUI and server to receive and display log4-log-messages.

Figure 45 shows the main GUI, which displays the arriving messages.

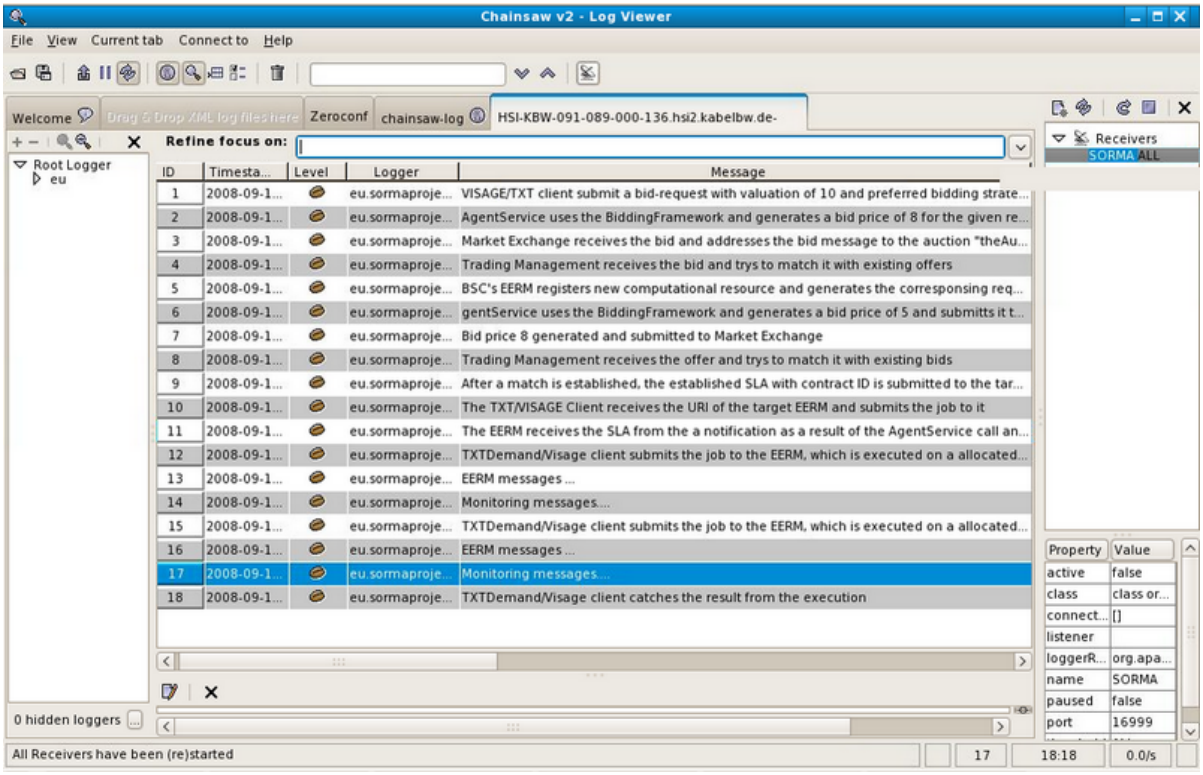


Figure 45: Chainsaw-Log GUI

Select manual configuration. The property windows, which appears by adding a **new receiver**-> SocketAppender. The only options to be set are name, port and threshold, the other settings are default.

Property	Value
active	true
class	class org.apache.log4j.net.SocketReceiver
connectedSocketDetails	[]
listener	
loggerRepository	org.apache.log4j.Hierarchy@79bca4
name	SORMA
paused	false
port	16999
threshold	ALL

Figure 46: Chainsaw Log properties

In order to submit and maintain "special" messages we defined a new log4j-level called **DEMO**. The required additional log4j configurations for both log4j-server and log4j-client (SORMA components) are shown in the following.

The **server.properties** are only required, when starting the loggingService instead of the Chainsaw-Log-GUI, the most important properties to be configured on each client are the log4j-client-properties (**log4j.properties**).

4.8.2. SORMA SLA Administration GUI

The SLA Administration GUI is packed with the SORMA ContractManagement component, and provides the capabilities for a system administrator to observe the state of active and complete SLAs in the SORMA Market Infrastructure. Here, the state of an SLA corresponds to violations in the agreement and also which life cycle state the SLA is in.

4.8.3. SORMA Security Management

This section describes how to use the administrative GUI to perform management of users, credentials and trusted identity providers. The administrative GUI used here is the GAARDS UI developed by the caGrid

a. Starting the Administration UI

1. First download the "Admin-ui.zip" package from the SORMA DVD:
   `/ivy/sorma/eu.sormaproject/security/LATEST/admin-ui.zip`
2. Extract the ZIP files and cd into the admin-ui directory.

```
$ unzip admin-ui.zip
$ cd admin-ui
```

3. Lastly, run the command to start the UI.

```
$ ./bin/start-ui
```

This will bring up the UI as shown in Figure 47:

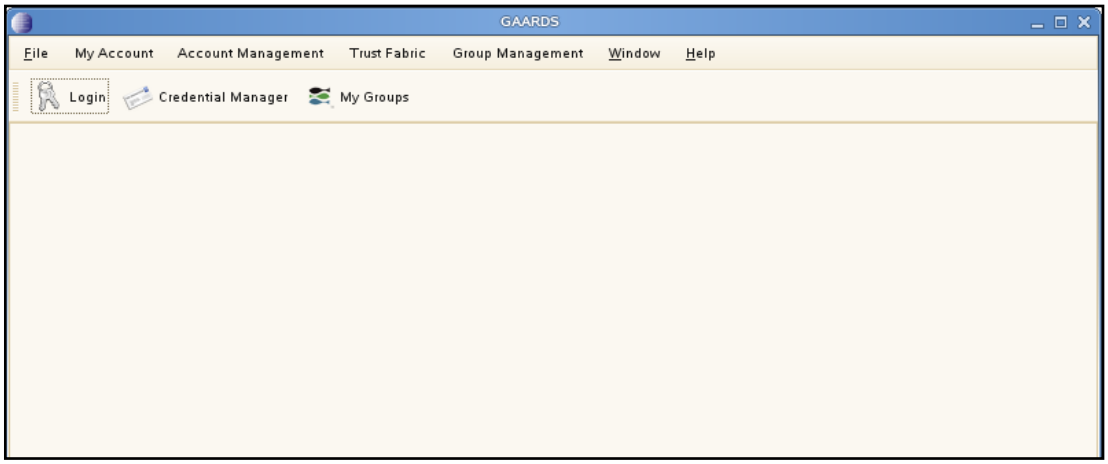


Figure 47: Security initial GUI

b. Setting the Security Service Endpoint

When the admin UI is first launched, you need to set the URL endpoint of the Security services.

1. Click on the Window menu, and then select Preferences. A new window will be displayed.
2. Under Preferences, select Grid User Management, then Dorian Service(s).
3. In the Add/Remove Value(s) text box, enter the URL of the Security services (e.g. https://<host>:<port>/sorma-security/services/SecurityManager) and click Add.

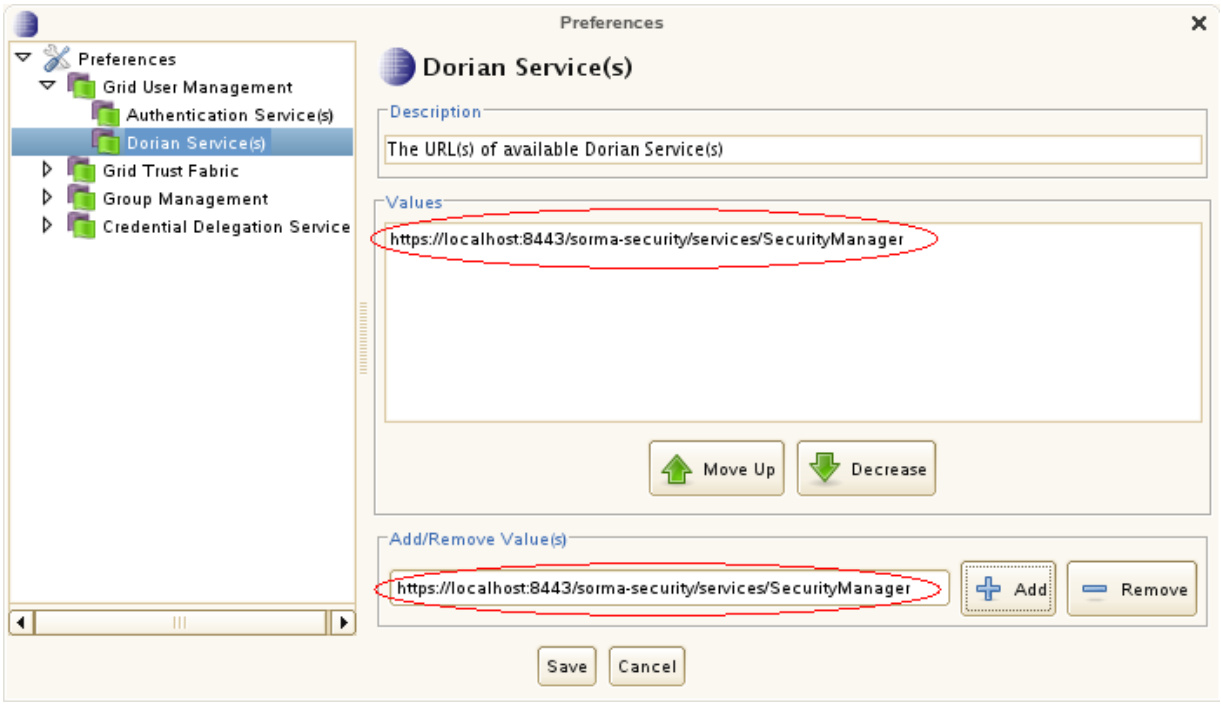


Figure 48: Security preferences

4. Click on Save to commit the changes.

c. Logging onto the Grid

Before performing any administration tasks, the administrator has to be authenticated.

1. Click on login in the task menu. A login menu will be displayed.

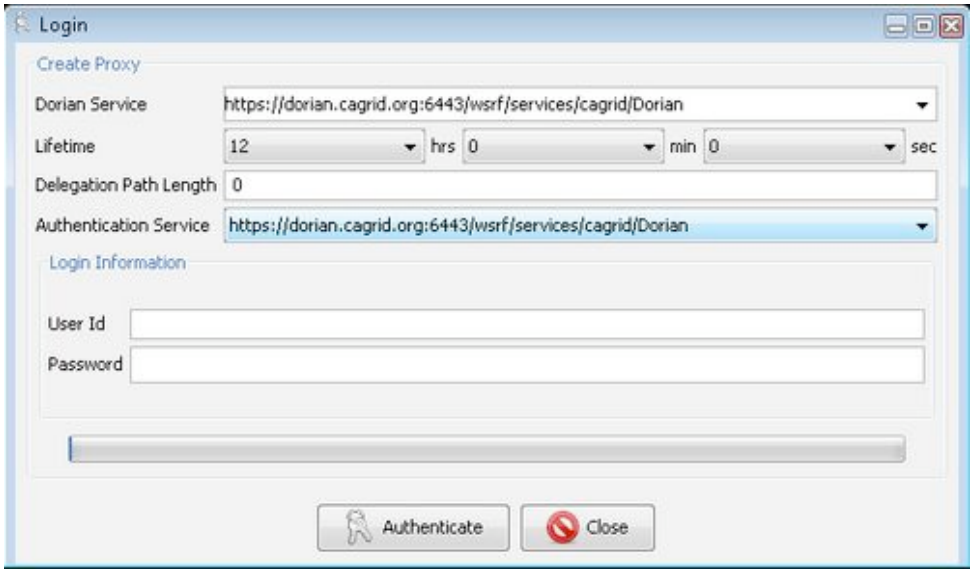


Figure 49: Security Log-in

2. From the Dorian service drop down menu select the URL pointing to your Security service.
3. Similarly, from Authentication Service drop down menu, select the same URL.
4. If this is the first time you are using the Administrator UI, you have to use the default administrator account to login.
5. In the User Id text box enter dorian
6. In the Password text box enter DorianAdmin$1
7. Click the Authenticate button.

If the login is successful, you will be authenticated and be given your credential. A window similar to that shown in Figure 50 should pop up containing the details of your credential.

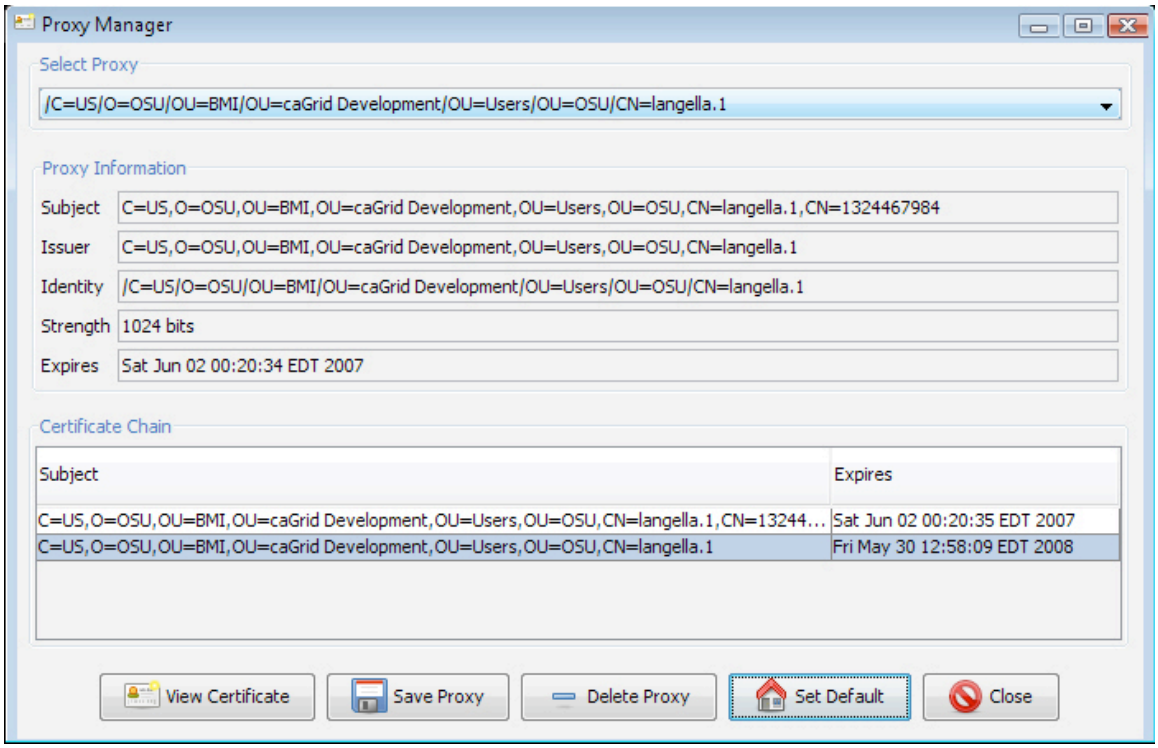


Figure 50: Proxy Manager

d. User Account Management

- **Register a New User:**

1. To register a new SORMA user, click on Account Management->Local Accounts->Registration.
2. A window should pop up with a form to enter the user's information.
3. Click on Apply to save the information to the database and create the user account.

- **Removing or Modifying a User:**

1. Select Account Management->Local Accounts->Local Account Management.
2. In the Search Criteria panel, you can enter the specific attributes of the users that you want to remove/modify. For example, to search for users who have suspended status, select from the User Status drop down box and choose Suspended. Then click on the Find User button to execute the search.
3. If the search is successful, the users that matched your criteria will be displayed. To manage a particular user, select the user and click on Manage User button, or the Remove User button to remove the user.

e. Managing Administrator

Only users that have been granted administrative access will be able to access the administrative features of the Security service. The administrative features include Account Management, Managing Trusted Identity Providers, and the ability to grant administrative access to users.

Administrative access can be managed through the administrator UI.

1. From the top menu bar, select Account Management->Grid Account Management->Administrators. This will bring up the administrative window (see Figure 51).

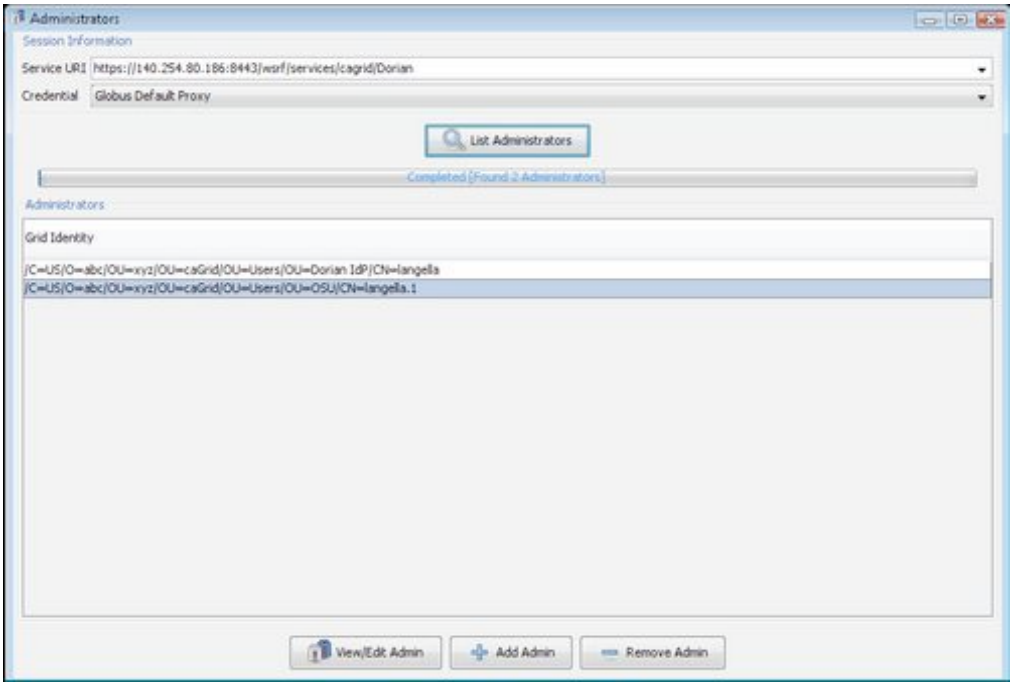


Figure 51: Administrator User Interface

2. From the Administrator window, you are allowed to:
   - List all the users with administrative access. This will list the grid identities of all the entities with administrative access in the Administrators table at the bottom of the screen.
   - Grant a user administrative access. Click the add Admin button. This will bring up the Add Administrator window which will prompt you to enter the grid identity of the user you wish to grant administrative access to. You can enter it directly or you can click the Find button to search for the user you wish to grant administrative access to.
   - Revoke a user's administrative access. This can be done by select the user from the Administrators table and click the Remove Admin button.
   - To grant a user administrative access click the Add Admin button.

5. SORMA System developer guide

This section provides practical information that will be useful to developers contributing to the SORMA system code base. Section 2.4 of this document titled "SORMA Software Development Methodology" provides an overview of the development methodology used in SORMA and should be read prior to proceeding with this section.

5.1. Getting Started with Ivy in SORMA

This section explains how to get started using SORMA's Ivy build mechanism and describes:

- How to configure the build environment for SORMA
- How to build an example component (library) and publish it to the Ivy repository

The prerequisites to use *Apache Ant* and *Apache Ivy* are the installation of Java 1.5 or later, Apache Ant 1.7.0 or later, an SVN client, an account on the SORMA SVN and repository server, and an Internet connection.

5.1.1. **Configure the environment**

Before using the SORMA build mechanisms for the first time, you need to configure the development environment by checking out the `build-bootstrap` directory from the SORMA Subversion:

```
svn export https://portals.rdg.ac.uk/sorma/svn/src/build-bootstrap
```

NOTE: The build-bootstrap directory can also be found on the SORMA DVD at: `/src/sorma/build-bootstrap`

The *build-bootstrap* contains:

- Standard Apache Ant build files that are shared across SORMA,
- Apache Ivy configuration settings,
- An example `build.properties` file, which has to be copied to your home directory (`${user.home}` in Java/Ant parlance) directory

The Ant files contained in `build-bootstrap` are important because SORMA components import these into their own Ant build scripts. The use of Ant imports means that the component build scripts are very simple and can contain as little as 7 lines (as long as the component adheres to the standard SORMA build layout).

In order to finalize the configuration of the Apache Ant +Ivy building environment the following steps are required :

1. Copy `build-bootstrap/build.properties` to the home directory (`${user.home}`) and edit the file appropriately (the file contains extensive comments).
2. Properties that must be set in `${user.home}/build.properties`:
    a. `build.bootstrap.dir`: The absolute path to the location of the checked out `build-bootstrap` directory. e.g. `build.bootstrap.dir=/home/user/workspace/SORMA/build-bootstrap`

b. `svn+ssh` related properties for interacting with the Integration and Vendor repositories (Account details are required) .NOTE: We only support the use of DSA certificate-based authentication to connect to the Ivy repositories using Ant.

3. Check that the `ant.classpath.dir` property points to a directory on the ant class path. Leave the property commented out to use the default of `${user.home}/.ant/lib`
4. Properties that should be set if behind a Corporate Proxy Server *:
   a. `proxyhost`
   b. `proxyport`
   c. `proxyuser`
   d. `proxypassword`

In order to turn on/off Web proxy support, just (un)comment the `proxyhost` property.

To configure the build environment properties and automatically download and insert the required jars to the ant classpath, change to the `build-bootstrap` directory and execute following command:

```
ant -f configure.xml
```

The required Jars will now have been installed on your classpath and you are ready to perform a build. If this step fails then make sure your proxy settings are correct (if you are behind a proxy).

5.1.2. **Building and publishing an example component (library)**

Checkout the `exampleIvyComponent` from SVN trunk or copy it from the DVD `src/sorma/trunk/exampleIvyComponent`) to a directory where you have read/write permissions. The directory structure will look like this:

```
doc: java-docs of the component
src: source code
test: source code of unit and integration tests
build.properties: common build properties of a component
build.xml: contains ant-based configuration with standardized and custom for building a component
ivy.xml: contains the ivy-based configuration of dependencies and publishing information
LICENSE.txt: contains license information
README.txt: contains specific information to building and execution of a component
```

To finding out what ant-targets are available to use, execute following command:

```
ant -p
```

The main SORMA targets:

```
targets:
clean: Clean up all files and directories that were generated by the build
clean-cache: Clean the ivy cache
clean-ivy: Clean the ivy installation
clean-local: Clean the current module from the local repository
compile: Compiles the source
compile-tests: Compiles the unit test source
enviro: Tests that the user's environment is configured to meet SORMA's highlevel requirements.
package: Packages the component into a jar file that is written to the component's build directory
```

```
publish: Publish this component in the SORMA Integration Ivy Repository (publishes
binary version only) for use by other developers
publish-local: Publish this component in the local ivy repository (on this
machine)
report: Generate a report of dependencies processed by Ivy (point your Web browser
at build/logs/
test: Execute Unit tests
```

The targets are fairly explanatory: *clean-local* and *clean-cache* are useful for cleaning out local artifacts; They has to be called when someone has published a new version of their component without changing the version id before publishing. The clean target is used to clean up all the artifacts generated by a component's build.

The *enviro* target currently tests to see if the java version is 1.5 or 1.6. Over time the environment tests will evolve as further prerequisites required for SORMA are identified across components. An example environment check:

```
ant enviro
```

Look inside the `ivy.xml` for the list of dependencies the component requires. In this example only the `sorma-common` library is required as shown in the following example:

```
<ivy-module version="2.0">
 <info organisation="eu.sormaproject" module="exampleComponent"/>
 <dependencies>
  <dependency org="eu.sormaproject" name="sorma-common" rev="latest.integration"/>
 </dependencies>
</ivy-module>
```

Use the following command to prepare the build directory, resolve dependencies listed in the ivy.xml, compile the source, and then compile and execute the unit tests:

```
ant
```

If we want to take a closer look at the dependency resolution that took place the following target can be called which results in an HTML file being written under the build directory, e.g: `/Users/gms/workspace/sorma-trunk/exampleIvyComponent/build/logs/ivy/eu.sormaproject-exampleComponent-default.html`.

```
ant report
```

Pointing a Web browser at the aforementioned HTML file results in something similar to the screenshot shown in Figure 52.

When all unit tests pass the component's binary can be published to your local repository for local integration testing:

```
ant publish-local
```

The `publish-local` command builds from source, tests, packages, and then publishes the binary version of the component to the local Ivy repository that resides on your workstation. Once in the local repository, other components that rely on the component just published can be built and tested. When all local integration tests pass, the component(s) can then be published to the SORMA-wide

integration repository, for further testing in conjunction with other developers. The command to achieve this is:

```
ant publish
```

Any other SORMA components owned by other SORMA developers, that reference this component in their *ivy.xml* dependency file, will now be able to retrieve the component from the integration repository as part of the their standard build. Components may either use an explicit version number to identify the dependency revision they require, or they can always opt to use the very latest version that is available (by specifying `latest.integration` in their Ivy dependency line).

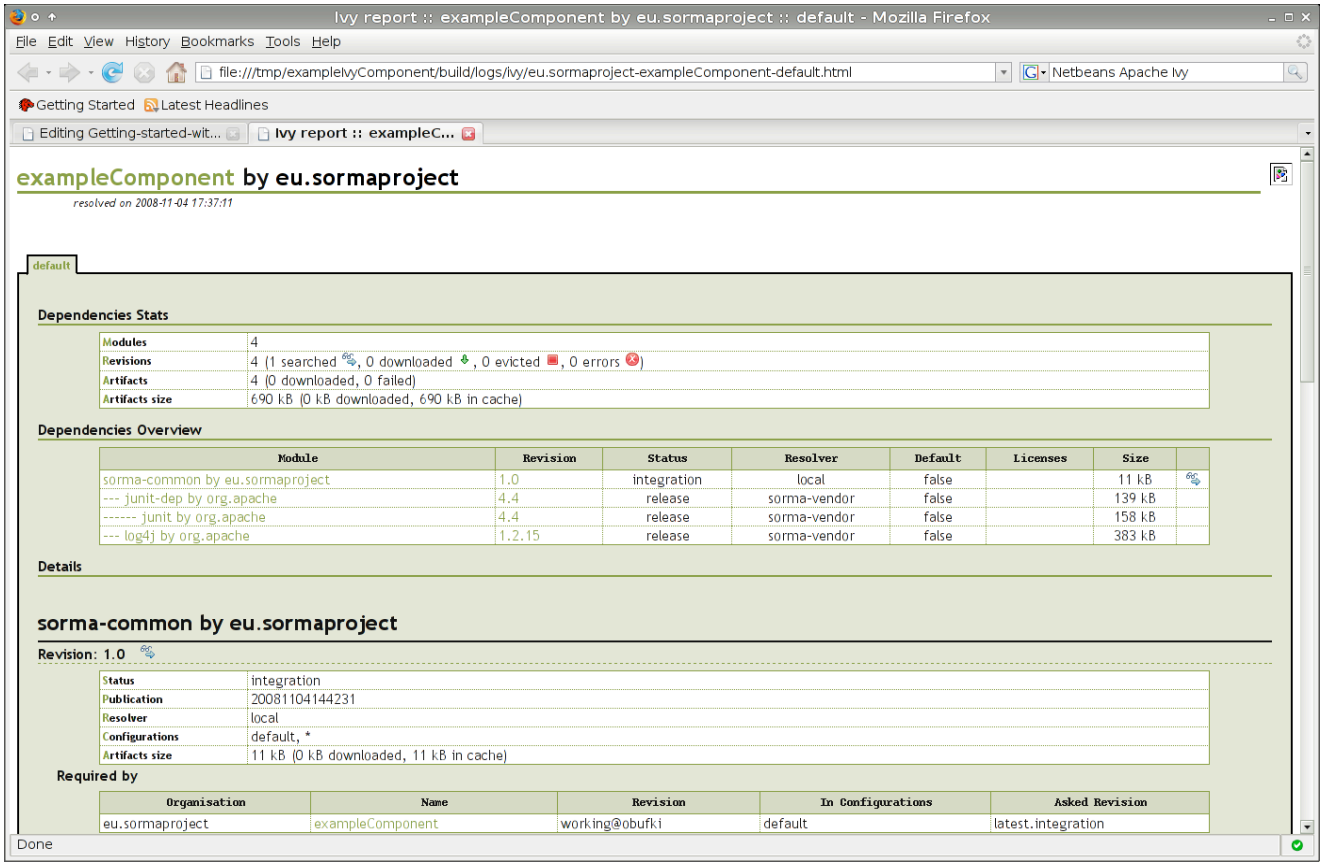


Figure 52: Screenshot of the HTML page generated by the `report` target showing dependency resolution information

If you successfully resolved dependencies, compiled, tested and published the exampleIvyComponent to the SORMA integration repository, then you have successfully configured your build environment for SORMA.

As a next step you could also look at Ivy plugins for your favourite Integrated Development Environment (IDE), and execute the ant targets from within the IDE.

- Plugins for Eclipse can be found at: http://ant.apache.org/ivy/ivyde/
- Plugins for Netbeans can be found at: http://wiki.netbeans.org/FaqIvy

5.2. Developing for SORMA

In this section we aim to provide further detail about the development process.

The *src* directory contains the component's source code. All code should be located under the *eu.sormaproject* root. To date we have been determining package structure based on where a component appears in the logical architecture. Examples include:

```
eu.sormaproject.openGridMarket.eerm
eu.sormaproject.coreMarketServices.marketExchange
```

The `test` directory contains unit testing (JUnit) and integration test code. The package structure under test is the same as that under `src`, which results in the test code being located in a parallel tree to the source code. The parallel test tree means that package-level visibility restrictions are not an issue and we keep a clear separation between our component's source code and the test code. The actual component code should not know anything about the test code.

A corresponding test directory for the example component looks like this:

```
test/eu/sormaproject/provider/example/AllMockServiceIntegrationTests.java
test/eu/sormaproject/provider/example/AllUnitTests.java
test/eu/sormaproject/provider/example/IntegrationTestSormaWorld.java
test/eu/sormaproject/provider/example/TestHelloSormaWorld.java
```

Unit tests and Integration tests are logically grouped according to the `AllUnitTests.java` and `AllMockServiceIntegrationTests.java` classes. This is because:

- Unit tests only test local classes and use local mock objects, therefore a test environment does not have to be specially created as testing never leaves the local JVM.
- Integration tests require the test environment and remote (Mock) Service Objects to be initialized. Integration tests could take quite a while to complete, where as unit tests should execute rapidly, so that e.g. thousands of tests can be executed in seconds.

Whereas unit test class names are prefixed with Test (e.g. `TestHelloSormaWorld.java`), by convention we prefix integration test classes with IntegrationTest (e.g. `IntegrationTestSormaWorld.java`).

XMLUnit[12] Tests are unit tests offering methods to test data specified in XML-format. The various SORMA message protocols are tested using XMLUnit.

Test parameters are passed to the unit testing code via `propertysets` that are defined in the component's `build.xml` file (more details below).

The component-level `build.properties` file contains component-specific parameters required to build and deploy the component. Required properties are given below with example values:

[12] http://xmlunit.sourceforge.net/

```
# Short name that is used to refer to this component
app.name=exampleComponent

# Used to identify the component's owning organisation to Ivy
ivy.organisation=eu.sormaproject

# Provides version information for the build and Ivy repository
app.version=0.2
```

Further properties can be included in `build.properties` as required by the `build.xml`.

The *ivy.xml* file defines:

- where in the repository the component will be published to (i.e. organization and component names),
- the component version number (read from build.properties),
- which other SORMA components the component depends on and
- which 3rd party libraries your component relies on as first-level dependencies, <*dependency*>.

An example ivy.xml looks like this:

```
<ivy-module version="2.0">
<info organisation="eu.sormaproject" module="exampleComponent"/>
 <dependencies>
  <dependency org="eu.sormaproject" name="sorma-common" rev="latest.integration"/>
 </dependencies>
</ivy-module>
```

The minimum *build.xml* to build, test and deploy a component is shown next, in this case the component build :

- adheres to the standard SORMA build layout,
- does not require custom properties to be passed to the unit/integration test code (notice the empty `unit-test-properties` and `integration-test-properties` `propertyset` elements),
- does not provide mock object injection (see later in this document),

```
<project name="exampleComponent" default="test" basedir=".">

   <property file="${user.home}/build.properties"/>
   <property file="build.properties"/>

   <import file="${build.bootstrap.dir}/sorma-lib-build.xml"/>
   <import file="${build.bootstrap.dir}/ivy-build.xml"/>

   <propertyset id="unit-test-properties"/>
   <propertyset id="integration-test-properties"/>

</project>
```

Any properties that have been set in your `${user.home}/build.properties`, take precedence over your component's own `build.properties`, which in turn take precedence over any properties that are set directly in the component's `build.xml` file. For example, the value for the `${build-bootstrap.dir}` property is retrieved from the developer's `${user.home}/build.properties` file (see also 5.1.1).

5.2.1. **Applications**

When implementing an application, the `build.xml` should import the following standard template:

```
<import file="${build.bootstrap.dir}/sorma-lib-build.xml"/>
```

and override the package target as required for your application's needs. For example, the following target will cause the application to be packaged in a tar file that is then compressed using the `gzip` command, resulting in a package with a `tar.gz` extension.

```
<target name="package" depends="targz" description="package application in a tar.gz file"/>
```

5.2.2. **Web Services**

When implementing a Web Service, the component's `build.xml` should import the following standard template:

```
<import file="${build.bootstrap.dir}/webapp-build.xml"/>
```

The most important Web Service related targets are:

```
webapp: builds a standard web application structure
webapp.war: this target jars the web application and named like configured e.g. war-file
webapp.tomcat.setup: This target copies specified setup files to the Tomcat's /common/lib directory
deploy: deploys a web application on tomcat
undeploy: undeploys a web application on tomcat
```

To just build the webapp directory structure (useful for inspection of the structure):

```
ant webapp
```

To create a `war` file the package target is overridden in the component's `build.xml`, eg:

```
<target name="package" depends="webapp.war" description="package application in a tar.gz file"/>
```

To deploy the Web Service directly to the Tomcat manager, the following target is used:

```
ant deploy
```

To undeploy:

```
ant undeploy
```

The standard targets are used for publishing the war file to the Ivy repository (i.e. `ant publish`).

5.2.3. **Sorma Ivy Portlet Developer Guide**

When implementing a JSR-168 portlet, the compoent's `build.xml` should import following standard template:

```
<import file="${build.bootstrap.dir}/portlet-build.xml"/>
```

In addition to the standard SORMA directory structure, a `webapp` directory needs to be present in the top-level of your component's source tree that follows the standard JSR-168 layout of:

```
css
html
js
jsp
WEB-INF
```

In addition, the component's `build.properties` are extended to include the following:

```
app.name=gridrmPortlets
app.version=0.9.2
ivy.organisation=org.gridrm

# Is this a JSR 168 or GridSphere/WebSphere webapp (jsr or gs)?
use.jsr=jsr

# location of gridsphere source and build directory. Override in your
~/build.properties
gridsphere.home=/home/gms/bin/gridsphere-2.2.8
gridsphere.build=${gridsphere.home}/build

# The following are required to workaround a bug in the build script and will be
redundant
# when the bug has been resolved. For now just include the following 3 properties
verbatim.

build.dir=${basedir}/build
build.classes=${build.dir}/classes
build.test=${build.dir}/test
```

The Gridsphere properties reference a Gridsphere 2.2.8 installation that must be installed before the portlet build will succeed.

To deploy the portlets to a local Gridsphere-installation, the following target is used:

```
ant deploy
```

The standard targets are used for publishing the portlet's war file to the Ivy repository (i.e. `ant publish`).

5.3. Further reading

For further details, please refer to the SORMA wiki at:
https://portals.rdg.ac.uk/sorma/mwiki/index.php/ApacheIvy,

Appendix

5.4. Examples of SORMA Messages

```
<PrivateDefinition requestId="request123" xmlns="http://www.sormaproject.eu/message/ejsdl/beans"
xmlns:add="http://schemas.xmlsoap.org/ws/2004/03/addressing"
xmlns:res="http://ws.sormaproject.eu/eerm/reservation"
xmlns:jsdl="http://schemas.ggf.org/jsdl/2005/11/jsdl">
  <add:EndpointReference>
    <add:Address>http://10.12.13.14:18080/EERM</add:Address>
  </add:EndpointReference>
  <res:reservation>
    <res:request>
      <res:fixed>
        <res:startTime>2009-01-10T12:00:00-05:00</res:startTime>
        <res:finishTime>2009-01-11T12:10:00-05:00</res:finishTime>
      </res:fixed>
    </res:request>
  </res:reservation>
  <jsdl:JobDefinition id="job123">
    <jsdl:JobDescription>
      <jsdl:JobIdentification>
        <jsdl:JobName>JobName</jsdl:JobName>
        <jsdl:Description>Description..</jsdl:Description>
        <jsdl:JobAnnotation/>
        <jsdl:JobProject/>
      </jsdl:JobIdentification>
      <jsdl:Application>
        <jsdl:Description>Appl description..</jsdl:Description>
      </jsdl:Application>
      <jsdl:Resources>
        <jsdl:CandidateHosts>
          <jsdl:HostName>www.sorma.eu</jsdl:HostName>
        </jsdl:CandidateHosts>
        <jsdl:OperatingSystem>
          <jsdl:OperatingSystemType>
            <jsdl:OperatingSystemName>Windows_XP</jsdl:OperatingSystemName>
          </jsdl:OperatingSystemType>
        </jsdl:OperatingSystem>
        <jsdl:CPUArchitecture>
          <jsdl:CPUArchitectureName>sparc</jsdl:CPUArchitectureName>
        </jsdl:CPUArchitecture>
        <jsdl:IndividualCPUSpeed>
          <jsdl:UpperBoundedRange>3333.0</jsdl:UpperBoundedRange>
          <jsdl:LowerBoundedRange>233.0</jsdl:LowerBoundedRange>
        </jsdl:IndividualCPUSpeed>
        <jsdl:IndividualCPUCount>
          <jsdl:UpperBoundedRange>5.0</jsdl:UpperBoundedRange>
          <jsdl:LowerBoundedRange>2.0</jsdl:LowerBoundedRange>
        </jsdl:IndividualCPUCount>
        <jsdl:IndividualPhysicalMemory>
          <jsdl:UpperBoundedRange>433434.0</jsdl:UpperBoundedRange>
          <jsdl:LowerBoundedRange>3455.0</jsdl:LowerBoundedRange>
        </jsdl:IndividualPhysicalMemory>
        <jsdl:IndividualDiskSpace>
          <jsdl:UpperBoundedRange>45455.0</jsdl:UpperBoundedRange>
          <jsdl:LowerBoundedRange>3445.0</jsdl:LowerBoundedRange>
        </jsdl:IndividualDiskSpace>
      </jsdl:Resources>
      <jsdl:DataStaging>
        <jsdl:FileName>fileName</jsdl:FileName>
        <jsdl:FilesystemName>fileSysName</jsdl:FilesystemName>
        <jsdl:CreationFlag>append</jsdl:CreationFlag>
      </jsdl:DataStaging>
    </jsdl:JobDescription>
  </jsdl:JobDefinition>
  <Penalty>
    <functionName>DefaultPenalty</functionName>
    <normalizationConstant>0.5</normalizationConstant>
  </Penalty>
  <PrivateData>
    <valuation>100</valuation>
    <strategy>QStrategy</strategy>
  </PrivateData>
```

```
  <Bid>
    <requestType>OFFER</requestType>
    <participantId>participant1</participantId>
    <timeout>1344</timeout>
    <duration>321</duration>
    <serviceType>WEBSERVICE</serviceType>
    <paymentType>EITHER</paymentType>
  </Bid>
</PrivateDefinition>
```

Example 1: EJSDLPrivate message

```
<BidDefinition bidId="bid123"
xmlns:add="http://schemas.xmlsoap.org/ws/2004/03/addressing"
xmlns="http://www.sormaproject.eu/message/ejsdl/beans"
xmlns:res="http://ws.sormaproject.eu/eerm/reservation"
xmlns:jsdl="http://schemas.ggf.org/jsdl/2005/11/jsdl">
    <add:EndpointReference>
        <add:Address>http://localhost:18080/EERM</add:Address>
    </add:EndpointReference>
  <res:reservation>
    <res:request>
      <res:fixed>
        <res:startTime>2009-01-10T12:00:00-05:00</res:startTime>
        <res:finishTime>2009-01-11T12:10:00-05:00</res:finishTime>
      </res:fixed>
    </res:request>
  </res:reservation>
  <jsdl:JobDefinition id="job123">
    <jsdl:JobDescription>
      <jsdl:JobIdentification>
        <jsdl:JobName>JobName</jsdl:JobName>
        <jsdl:Description>Description..</jsdl:Description>
        <jsdl:JobAnnotation/>
        <jsdl:JobProject/>
      </jsdl:JobIdentification>
      <jsdl:Application>
        <jsdl:Description>Appl description..</jsdl:Description>
      </jsdl:Application>
      <jsdl:Resources>
        <jsdl:CandidateHosts>
          <jsdl:HostName>www.sorma.eu</jsdl:HostName>
        </jsdl:CandidateHosts>
        <jsdl:OperatingSystem>
          <jsdl:OperatingSystemType>
            <jsdl:OperatingSystemName>Windows_XP</jsdl:OperatingSystemName>
          </jsdl:OperatingSystemType>
        </jsdl:OperatingSystem>
        <jsdl:CPUArchitecture>
          <jsdl:CPUArchitectureName>sparc</jsdl:CPUArchitectureName>
        </jsdl:CPUArchitecture>
        <jsdl:IndividualCPUSpeed>
          <jsdl:UpperBoundedRange>1000.0</jsdl:UpperBoundedRange>
          <jsdl:LowerBoundedRange>100.0</jsdl:LowerBoundedRange>
        </jsdl:IndividualCPUSpeed>
        <jsdl:IndividualCPUCount>
          <jsdl:UpperBoundedRange>5.0</jsdl:UpperBoundedRange>
          <jsdl:LowerBoundedRange>2.0</jsdl:LowerBoundedRange>
        </jsdl:IndividualCPUCount>
        <jsdl:IndividualPhysicalMemory>
          <jsdl:UpperBoundedRange>1000.0</jsdl:UpperBoundedRange>
          <jsdl:LowerBoundedRange>500.0</jsdl:LowerBoundedRange>
        </jsdl:IndividualPhysicalMemory>
        <jsdl:IndividualDiskSpace>
          <jsdl:UpperBoundedRange>10000.0</jsdl:UpperBoundedRange>
          <jsdl:LowerBoundedRange>5000.0</jsdl:LowerBoundedRange>
        </jsdl:IndividualDiskSpace>
      </jsdl:Resources>
      <jsdl:DataStaging>
        <jsdl:FileName>fileName</jsdl:FileName>
        <jsdl:FilesystemName>fileSysName</jsdl:FilesystemName>
        <jsdl:CreationFlag>append</jsdl:CreationFlag>
      </jsdl:DataStaging>
    </jsdl:JobDescription>
  </jsdl:JobDefinition>
  <Bid>
    <bidPrice>50.0</bidPrice>
```

```
    <requestType>BID</requestType>
    <participantId>participant1</participantId>
    <timeout>100000</timeout>
    <duration>2000</duration>
    <serviceType>WEBSERVICE</serviceType>
    <paymentType>EITHER</paymentType>
  </Bid>
</BidDefinition>
```

Example 2: the bid message EJSDL

```
<MarketDefinition marketMessageId="bidId-offerId"
xmlns="http://www.sormaproject.eu/message/ejsdl/beans"
xmlns:add="http://schemas.xmlsoap.org/ws/2004/03/addressing"
xmlns:res="http://ws.sormaproject.eu/eerm/reservation"
xmlns:jsdl="http://schemas.ggf.org/jsdl/2005/11/jsdl">
  <add:EndpointReference>
    <add:Address>http://localhost:18080/EERM</add:Address>
  </add:EndpointReference>
  <res:reservation>
    <res:request>
      <res:fixed>
        <res:startTime>2008-11-10T12:00:00-05:00</res:startTime>
        <res:finishTime>2008-11-10T12:00:00-05:00</res:finishTime>
      </res:fixed>
    </res:request>
  </res:reservation>
  <jsdl:JobDefinition>
    <jsdl:JobDescription>
      <jsdl:JobIdentification>
        <jsdl:JobName>JobName</jsdl:JobName>
        <jsdl:Description>Description..</jsdl:Description>
        <jsdl:JobAnnotation/>
        <jsdl:JobProject/>
      </jsdl:JobIdentification>
      <jsdl:Application>
        <jsdl:Description>Appl description..</jsdl:Description>
      </jsdl:Application>
      <jsdl:Resources>
        <jsdl:CandidateHosts>
          <jsdl:HostName>www.sorma.eu</jsdl:HostName>
        </jsdl:CandidateHosts>
        <jsdl:OperatingSystem>
          <jsdl:OperatingSystemType>
            <jsdl:OperatingSystemName>Windows_XP</jsdl:OperatingSystemName>
          </jsdl:OperatingSystemType>
        </jsdl:OperatingSystem>
        <jsdl:CPUArchitecture>
          <jsdl:CPUArchitectureName>sparc</jsdl:CPUArchitectureName>
        </jsdl:CPUArchitecture>
        <jsdl:IndividualCPUSpeed>
          <jsdl:UpperBoundedRange>3333.0</jsdl:UpperBoundedRange>
          <jsdl:LowerBoundedRange>233.0</jsdl:LowerBoundedRange>
        </jsdl:IndividualCPUSpeed>
        <jsdl:IndividualCPUCount>
          <jsdl:UpperBoundedRange>5.0</jsdl:UpperBoundedRange>
          <jsdl:LowerBoundedRange>2.0</jsdl:LowerBoundedRange>
        </jsdl:IndividualCPUCount>
        <jsdl:IndividualPhysicalMemory>
          <jsdl:UpperBoundedRange>433434.0</jsdl:UpperBoundedRange>
          <jsdl:LowerBoundedRange>3455.0</jsdl:LowerBoundedRange>
        </jsdl:IndividualPhysicalMemory>
        <jsdl:IndividualDiskSpace>
          <jsdl:UpperBoundedRange>45455.0</jsdl:UpperBoundedRange>
          <jsdl:LowerBoundedRange>3445.0</jsdl:LowerBoundedRange>
        </jsdl:IndividualDiskSpace>
      </jsdl:Resources>
      <jsdl:DataStaging>
        <jsdl:FileName>fileName</jsdl:FileName>
        <jsdl:FilesystemName>fileSysName</jsdl:FilesystemName>
        <jsdl:CreationFlag>append</jsdl:CreationFlag>
      </jsdl:DataStaging>
    </jsdl:JobDescription>
  </jsdl:JobDefinition>
  <Penalty>
    <functionName>DefaultPenalty</functionName>
    <normalizationConstant>0.5</normalizationConstant>
  </Penalty>
```

```
  <MarketMessage>
    <clearingPrice>33.0</clearingPrice>
    <contractId>contractId</contractId>
    <ConsumerContext>
      <PartipantId>consumerId</PartipantId>
      <BidId>bidId</BidId>
    </ConsumerContext>
    <ProviderContext>
      <PartipantId>providerId</PartipantId>
      <BidId>offerId</BidId>
    </ProviderContext>
    <requestType>MATCH</requestType>
    <duration>321</duration>
    <serviceType>WEBSERVICE</serviceType>
    <paymentType>EITHER</paymentType>
  </MarketMessage>
</MarketDefinition>
```

Example 3: Market message EJSDLMarket

```
<AgreementOffer ws:AgreementId="consumerId-providerId-1234892098656"
xmlns="http://schemas.ggf.org/graap/2007/03/ws-agreement"
xmlns:ws="http://schemas.ggf.org/graap/2007/03/ws-agreement"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <Context>
    <AgreementInitiator xsi:type="bean:Context_Type"
xmlns:bean="http://www.sormaproject.eu/message/ejsdl/beans"
xmlns:jsdl="http://schemas.ggf.org/jsdl/2005/11/jsdl"
xmlns:add="http://schemas.xmlsoap.org/ws/2004/03/addressing">
      <bean:PartipantId>consumerId</bean:PartipantId>
      <bean:BidId>bidId</bean:BidId>
    </AgreementInitiator>
    <AgreementResponder xsi:type="bean:Context_Type"
xmlns:bean="http://www.sormaproject.eu/message/ejsdl/beans"
xmlns:jsdl="http://schemas.ggf.org/jsdl/2005/11/jsdl"
xmlns:add="http://schemas.xmlsoap.org/ws/2004/03/addressing">
      <bean:PartipantId>providerId</bean:PartipantId>
      <bean:BidId>offerId</bean:BidId>
    </AgreementResponder>
    <ServiceProvider>AgreementResponder</ServiceProvider>
  </Context>
  <Terms>
    <All>
      <ServiceDescriptionTerm ws:ServiceName="myJobId1234" ws:Name="JSDL">
        <jsdl:JobDefinition id="myJobId1234" xmlns:jsdl="http://schemas.ggf.org/jsdl/2005/11/jsdl"
xmlns:add="http://schemas.xmlsoap.org/ws/2004/03/addressing">
          <jsdl:JobDescription>
            <jsdl:JobIdentification>
              <jsdl:JobName>POVRAYJob</jsdl:JobName>
              <jsdl:Description>Ray Traycing</jsdl:Description>
              <jsdl:JobAnnotation>jobPR</jsdl:JobAnnotation>
              <jsdl:JobProject>RT</jsdl:JobProject>
            </jsdl:JobIdentification>
            <jsdl:Application>
              <jsdl:ApplicationName>Pov-Ray</jsdl:ApplicationName>
              <POSIXApplication xmlns="http://schemas.ggf.org/jsdl/2005/11/jsdl-posix">
                <Executable>./povray</Executable>
                <Argument>+I${input_file}</Argument>
                <Argument>+O${output_file}</Argument>
                <Argument>+W${width}</Argument>
                <Argument>+H${height}</Argument>
              </POSIXApplication>
            </jsdl:Application>
            <jsdl:Resources />
            <jsdl:DataStaging>
              <jsdl:FileName>colors.inc</jsdl:FileName>
              <jsdl:CreationFlag>overwrite</jsdl:CreationFlag>
              <jsdl:DeleteOnTermination>false</jsdl:DeleteOnTermination>
              <jsdl:Source>
                <jsdl:URI>${input_files_location}/pov/colors.inc</jsdl:URI>
              </jsdl:Source>
            </jsdl:DataStaging>
            <jsdl:DataStaging>
              <jsdl:FileName>finish.inc</jsdl:FileName>
              <jsdl:CreationFlag>overwrite</jsdl:CreationFlag>
              <jsdl:DeleteOnTermination>false</jsdl:DeleteOnTermination>
              <jsdl:Source>
```

```
              <jsdl:URI>${input_files_location}/pov/finish.inc</jsdl:URI>
            </jsdl:Source>
          </jsdl:DataStaging>
          <jsdl:DataStaging>
            <jsdl:FileName>textures.inc</jsdl:FileName>
            <jsdl:CreationFlag>overwrite</jsdl:CreationFlag>
            <jsdl:DeleteOnTermination>false</jsdl:DeleteOnTermination>
            <jsdl:Source>
              <jsdl:URI>${input_files_location}/pov/textures.inc</jsdl:URI>
            </jsdl:Source>
          </jsdl:DataStaging>
          <jsdl:DataStaging>
            <jsdl:FileName>povray</jsdl:FileName>
            <jsdl:CreationFlag>overwrite</jsdl:CreationFlag>
            <jsdl:DeleteOnTermination>false</jsdl:DeleteOnTermination>
            <jsdl:Source>
              <jsdl:URI>${input_files_location}/povray</jsdl:URI>
            </jsdl:Source>
          </jsdl:DataStaging>
          <jsdl:DataStaging>
            <jsdl:FileName>${input_file}</jsdl:FileName>
            <jsdl:CreationFlag>overwrite</jsdl:CreationFlag>
            <jsdl:DeleteOnTermination>false</jsdl:DeleteOnTermination>
            <jsdl:Source>
              <jsdl:URI>${input_files_location}/pov/${input_file}</jsdl:URI>
            </jsdl:Source>
          </jsdl:DataStaging>
          <jsdl:DataStaging>
            <jsdl:FileName>${output_file}</jsdl:FileName>
            <jsdl:CreationFlag>overwrite</jsdl:CreationFlag>
            <jsdl:Target>
              <jsdl:URI>${output_files_location}/${output_file}</jsdl:URI>
            </jsdl:Target>
          </jsdl:DataStaging>
        </jsdl:JobDescription>
      </jsdl:JobDefinition>
    </ServiceDescriptionTerm>
    <ServiceProperties ws:ServiceName="myJobId1234">
      <VariableSet>
        <Variable ws:Name="CPUArchitecture" ws:Metric="jsdl:CPUArchitecture">
          <Location>/JobDescription/Resources/CPUArchitecture</Location>
        </Variable>
        <Variable ws:Name="CandidateHosts" ws:Metric="jsdl:CandidateHosts">
          <Location>/JobDescription/Resources/CandidateHosts</Location>
        </Variable>
        <Variable ws:Name="IndividualCPUCount" ws:Metric="jsdl:IndividualCPUCount">
          <Location>/JobDescription/Resources/IndividualCPUCount</Location>
        </Variable>
        <Variable ws:Name="IndividualCPUSpeed" ws:Metric="jsdl:IndividualCPUSpeed">
          <Location>/JobDescription/Resources/IndividualCPUSpeed</Location>
        </Variable>
        <Variable ws:Name="IndividualDiskSpace" ws:Metric="jsdl:IndividualDiskSpace">
          <Location>/JobDescription/Resources/IndividualDiskSpace</Location>
        </Variable>
        <Variable ws:Name="IndividualPhysicalMemory" ws:Metric="jsdl:IndividualPhysicalMemory">
          <Location>/JobDescription/Resources/IndividualPhysicalMemory</Location>
        </Variable>
      </VariableSet>
    </ServiceProperties>
    <GuaranteeTerm ws:Name="CPUArchitecture" ws:Obligated="ServiceProvider">
      <ServiceScope ws:ServiceName="myJobId1234"/>
      <ServiceLevelObjective>
        <KPITarget>
          <KPIName>jsdl:CPUArchitecture</KPIName>
          <CustomServiceLevel xsi:type="jsdl:CPUArchitecture_Type"
xmlns:jsdl="http://schemas.ggf.org/jsdl/2005/11/jsdl"
xmlns:add="http://schemas.xmlsoap.org/ws/2004/03/addressing">
            <jsdl:CPUArchitectureName>x86</jsdl:CPUArchitectureName>
          </CustomServiceLevel>
        </KPITarget>
      </ServiceLevelObjective>
      <BusinessValueList>
        <Importance>1</Importance>
        <Penalty>
          <AssessmentInterval>
            <TimeInterval>PT30S</TimeInterval>
          </AssessmentInterval>
```

```
            <ValueExpression xsi:type="bean:Penalty_Type"
xmlns:jsdl="http://schemas.ggf.org/jsdl/2005/11/jsdl"
xmlns:add="http://schemas.xmlsoap.org/ws/2004/03/addressing"
xmlns:bean="http://www.sormaproject.eu/message/ejsdl/beans">
              <bean:functionName>DefaultPenalty</bean:functionName>
              <bean:normalizationConstant>1.0</bean:normalizationConstant>
            </ValueExpression>
          </Penalty>
          <Reward>
            <ValueExpression xsi:type="bean:MarketMessage_Type"
xmlns:bean="http://www.sormaproject.eu/message/ejsdl/beans">
              <bean:currency xsi:nil="true"/>
              <bean:paymentType>EITHER</bean:paymentType>
              <bean:clearingPrice>3.3333333333333335</bean:clearingPrice>
            </ValueExpression>
          </Reward>
        </BusinessValueList>
      </GuaranteeTerm>
      <GuaranteeTerm ws:Name="CandidateHosts" ws:Obligated="ServiceProvider">
        <ServiceScope ws:ServiceName="myJobId1234"/>
        <ServiceLevelObjective>
          <KPITarget>
            <KPIName>jsdl:CandidateHosts</KPIName>
            <CustomServiceLevel xsi:type="jsdl:CandidateHosts_Type"
xmlns:jsdl="http://schemas.ggf.org/jsdl/2005/11/jsdl"
xmlns:add="http://schemas.xmlsoap.org/ws/2004/03/addressing">
              <jsdl:HostName>10.10.10.10</jsdl:HostName>
            </CustomServiceLevel>
          </KPITarget>
        </ServiceLevelObjective>
        <BusinessValueList>
          <Importance>1</Importance>
          <Penalty>
            <AssessmentInterval>
              <TimeInterval>PT30S</TimeInterval>
            </AssessmentInterval>
            <ValueExpression xsi:type="bean:Penalty_Type"
xmlns:jsdl="http://schemas.ggf.org/jsdl/2005/11/jsdl"
xmlns:add="http://schemas.xmlsoap.org/ws/2004/03/addressing"
xmlns:bean="http://www.sormaproject.eu/message/ejsdl/beans">
              <bean:functionName>DefaultPenalty</bean:functionName>
              <bean:normalizationConstant>1.0</bean:normalizationConstant>
            </ValueExpression>
          </Penalty>
          <Reward>
            <ValueExpression xsi:type="bean:MarketMessage_Type"
xmlns:bean="http://www.sormaproject.eu/message/ejsdl/beans">
              <bean:currency xsi:nil="true"/>
              <bean:paymentType>EITHER</bean:paymentType>
              <bean:clearingPrice>3.3333333333333335</bean:clearingPrice>
            </ValueExpression>
          </Reward>
        </BusinessValueList>
      </GuaranteeTerm>
      <GuaranteeTerm ws:Name="IndividualCPUCount" ws:Obligated="ServiceProvider">
        <ServiceScope ws:ServiceName="myJobId1234"/>
        <ServiceLevelObjective>
          <KPITarget>
            <KPIName>jsdl:IndividualCPUCount</KPIName>
            <CustomServiceLevel xsi:type="jsdl:RangeValue_Type"
xmlns:jsdl="http://schemas.ggf.org/jsdl/2005/11/jsdl"
xmlns:add="http://schemas.xmlsoap.org/ws/2004/03/addressing">
              <jsdl:UpperBoundedRange>4.0</jsdl:UpperBoundedRange>
              <jsdl:LowerBoundedRange>2.0</jsdl:LowerBoundedRange>
            </CustomServiceLevel>
          </KPITarget>
        </ServiceLevelObjective>
        <BusinessValueList>
          <Importance>1</Importance>
          <Penalty>
            <AssessmentInterval>
              <TimeInterval>PT30S</TimeInterval>
            </AssessmentInterval>
            <ValueExpression xsi:type="bean:Penalty_Type"
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xmlns:add="http://schemas.xmlsoap.org/ws/2004/03/addressing"
xmlns:bean="http://www.sormaproject.eu/message/ejsdl/beans">
              <bean:functionName>DefaultPenalty</bean:functionName>
```

```
              <bean:normalizationConstant>1.0</bean:normalizationConstant>
            </ValueExpression>
          </Penalty>
          <Reward>
            <ValueExpression xsi:type="bean:MarketMessage_Type"
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              <bean:currency xsi:nil="true"/>
              <bean:paymentType>EITHER</bean:paymentType>
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        </BusinessValueList>
      </GuaranteeTerm>
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        <ServiceLevelObjective>
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            <CustomServiceLevel xsi:type="jsdl:RangeValue_Type"
xmlns:jsdl="http://schemas.ggf.org/jsdl/2005/11/jsdl"
xmlns:add="http://schemas.xmlsoap.org/ws/2004/03/addressing">
              <jsdl:UpperBoundedRange>2000.0</jsdl:UpperBoundedRange>
              <jsdl:LowerBoundedRange>200.0</jsdl:LowerBoundedRange>
            </CustomServiceLevel>
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        </ServiceLevelObjective>
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            <AssessmentInterval>
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            </AssessmentInterval>
            <ValueExpression xsi:type="bean:Penalty_Type"
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xmlns:add="http://schemas.xmlsoap.org/ws/2004/03/addressing"
xmlns:bean="http://www.sormaproject.eu/message/ejsdl/beans">
              <bean:functionName>DefaultPenalty</bean:functionName>
              <bean:normalizationConstant>1.0</bean:normalizationConstant>
            </ValueExpression>
          </Penalty>
          <Reward>
            <ValueExpression xsi:type="bean:MarketMessage_Type"
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              <bean:paymentType>EITHER</bean:paymentType>
              <bean:clearingPrice>3.3333333333333335</bean:clearingPrice>
            </ValueExpression>
          </Reward>
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        <ServiceScope ws:ServiceName="myJobId1234"/>
        <ServiceLevelObjective>
          <KPITarget>
            <KPIName>jsdl:IndividualDiskSpace</KPIName>
            <CustomServiceLevel xsi:type="jsdl:RangeValue_Type"
xmlns:jsdl="http://schemas.ggf.org/jsdl/2005/11/jsdl"
xmlns:add="http://schemas.xmlsoap.org/ws/2004/03/addressing">
              <jsdl:UpperBoundedRange>2000000.0</jsdl:UpperBoundedRange>
              <jsdl:LowerBoundedRange>100000.0</jsdl:LowerBoundedRange>
            </CustomServiceLevel>
          </KPITarget>
        </ServiceLevelObjective>
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          <Penalty>
            <AssessmentInterval>
              <TimeInterval>PT30S</TimeInterval>
            </AssessmentInterval>
            <ValueExpression xsi:type="bean:Penalty_Type"
xmlns:jsdl="http://schemas.ggf.org/jsdl/2005/11/jsdl"
xmlns:add="http://schemas.xmlsoap.org/ws/2004/03/addressing"
xmlns:bean="http://www.sormaproject.eu/message/ejsdl/beans">
              <bean:functionName>DefaultPenalty</bean:functionName>
              <bean:normalizationConstant>1.0</bean:normalizationConstant>
            </ValueExpression>
          </Penalty>
          <Reward>
```

```
            <ValueExpression xsi:type="bean:MarketMessage_Type"
xmlns:bean="http://www.sormaproject.eu/message/ejsdl/beans">
              <bean:currency xsi:nil="true"/>
              <bean:paymentType>EITHER</bean:paymentType>
              <bean:clearingPrice>3.3333333333333335</bean:clearingPrice>
            </ValueExpression>
          </Reward>
        </BusinessValueList>
      </GuaranteeTerm>
      <GuaranteeTerm ws:Name="IndividualPhysicalMemory" ws:Obligated="ServiceProvider">
        <ServiceScope ws:ServiceName="myJobId1234"/>
        <ServiceLevelObjective>
          <KPITarget>
            <KPIName>jsdl:IndividualPhysicalMemory</KPIName>
            <CustomServiceLevel xsi:type="jsdl:RangeValue_Type"
xmlns:jsdl="http://schemas.ggf.org/jsdl/2005/11/jsdl"
xmlns:add="http://schemas.xmlsoap.org/ws/2004/03/addressing">
              <jsdl:UpperBoundedRange>300.0</jsdl:UpperBoundedRange>
              <jsdl:LowerBoundedRange>200.0</jsdl:LowerBoundedRange>
            </CustomServiceLevel>
          </KPITarget>
        </ServiceLevelObjective>
        <BusinessValueList>
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          <Penalty>
            <AssessmentInterval>
              <TimeInterval>PT30S</TimeInterval>
            </AssessmentInterval>
            <ValueExpression xsi:type="bean:Penalty_Type"
xmlns:jsdl="http://schemas.ggf.org/jsdl/2005/11/jsdl"
xmlns:add="http://schemas.xmlsoap.org/ws/2004/03/addressing"
xmlns:bean="http://www.sormaproject.eu/message/ejsdl/beans">
              <bean:functionName>DefaultPenalty</bean:functionName>
              <bean:normalizationConstant>1.0</bean:normalizationConstant>
            </ValueExpression>
          </Penalty>
          <Reward>
            <ValueExpression xsi:type="bean:MarketMessage_Type"
xmlns:bean="http://www.sormaproject.eu/message/ejsdl/beans">
              <bean:currency xsi:nil="true"/>
              <bean:paymentType>EITHER</bean:paymentType>
              <bean:clearingPrice>3.3333333333333335</bean:clearingPrice>
            </ValueExpression>
          </Reward>
        </BusinessValueList>
      </GuaranteeTerm>
      <ServiceReference ws:Name="EERMEndpoint" ws:ServiceName="Job ExecutionALL">
        <add:EndpointReference xmlns:jsdl="http://schemas.ggf.org/jsdl/2005/11/jsdl"
xmlns:add="http://schemas.xmlsoap.org/ws/2004/03/addressing">
          <add:Address>http://localhost:18080/EERM</add:Address>
        </add:EndpointReference>
      </ServiceReference>
    </All>
  </Terms>
</AgreementOffer>
```

Example 4: WS-Agreement example of the contract

SORMA Consortium

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